# DETAILED STUDY OF THE SIMCOE COAL GASIFICATION PLANT SITE

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## ACKNOWLEDGEMENT AND DISCLAIMER

This report was prepared for the Ontario Ministry of the Environment as part of a Ministry funded project. The views contained within this report are those of this author and do not necessarily reflect the position or policies of the Ministry of the Environment.

## EXECUTIVE SUMMARY

This report describes the results of a detailed study of the Simcoe coal gasification plant site. The Simcoe site is one of many former coal gasification plant sites in the Province of Ontario which are currently being investigated by property owners and the Ontario Ministry of the Environment. The Simcoe site was identified by an earlier inventory study as likely having buried coal tar wastes both on-site and off-site in proximity to the Lynn River. Coal tar wastes contain polynuclear aromatic hydrocarbons (PAH) and monocyclic aromatic hydrocarbons (MAH) many of which are toxic and some of which are carcinogenic.

The general objectives of this detailed study were to investigate the existing or potential hazards to humans and the environment that such wastes, if present, may pose and to recommend remedial measures to mitigate such hazards. The study objectives were achieved through review of existing site information and the performance of field studies to determine site conditions including the extent and nature of contamination.

Reviews of archival information including gas plant plans, historical lease agreements and Town of Simcoe By-Laws show that the Simcoe gas works operated from about 1891 to cal911. During this period, coal tar and coal tar wastes were likely produced from retort coal gasification facilities which operated on the southeast corner of Pond and Water Streets adjacent to the Lynn River. The site is now owned by the Town of Simcoe and occupied by the Haldimand Norfolk Information Centre, Lynn River Scout Association, the Simcoe Seniors' Centre, and a pottery workshop.

Field investigations were performed to determine the nature and extent of contamination of air, groundwater, sediment and soil in the area of the former gas works. These investigations included air quality sampling, inspection of utility lines, sediment sampling of the Lynn River and drilling, soil sampling, well installation and groundwater sampling.

The results of the site investigations show that a 15 m x 40 m area of coal tar contaminated soil and groundwater exists between the former gas works and the Lynn River. The soil in this area is characterized by adsorbed and immobile coal tar wastes. Groundwater in this area shows trace to low levels of priority PAH and some MAH compounds. No free product or separate phase coal tar was observed on-site.

Inspections and sampling of the Lynn River shows that there is negligible loading of coal tar wastes to River from the former gas works site. Groundwater discharging to the River contains non-detectable to trace levels of selected MAH and PAH.

Air quality sampling performed within the Seniors' Centre, in the basement of Information Centre and outside adjacent to the Lynn River shows that the air quality at the site has not been impacted by coal tar wastes.

In summary, the available test results show that there is negligible impact on human health and the environment posed by the former Simcoe gas works site. Consequently, there is no need to undertake remedial action at this site. Future excavation at the site may expose coal tar wastes and safety precautions should be followed to minimize human exposure and dispersal of such wastes to the environment.

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# 1. INTRODUCTION

## 1.1 BACKGROUND

An inventory of former municipal coal gasification plant waste sites in the Province of Ontario was released by the Ministry of the Environment in June, 1987. This inventory study, completed by Intera Technologies Ltd. (INTERA) identified 41 sites and a major Ministry program is currently underway to investigate more fully the existing or potential hazard to humans or the environment that these sites may pose.

The inventory study suggested and subsequent site investigations have confirmed the fact that coal gasification plant wastes principally as residual coal tar exist at former coal gasification plant sites. The Simcoe coal gasification plant was a small facility that operated from 1891 to ca1911, at the southeast corner of Pond and Water Streets adjacent to the Lynn River (Figure 1.1). The current investigation was prompted by reports of "oily" odours in the Simcoe Seniors' Centre building which overlies some of the former gas plant facilities and concern over environmental impact to the Lynn River from residual coal tar wastes.

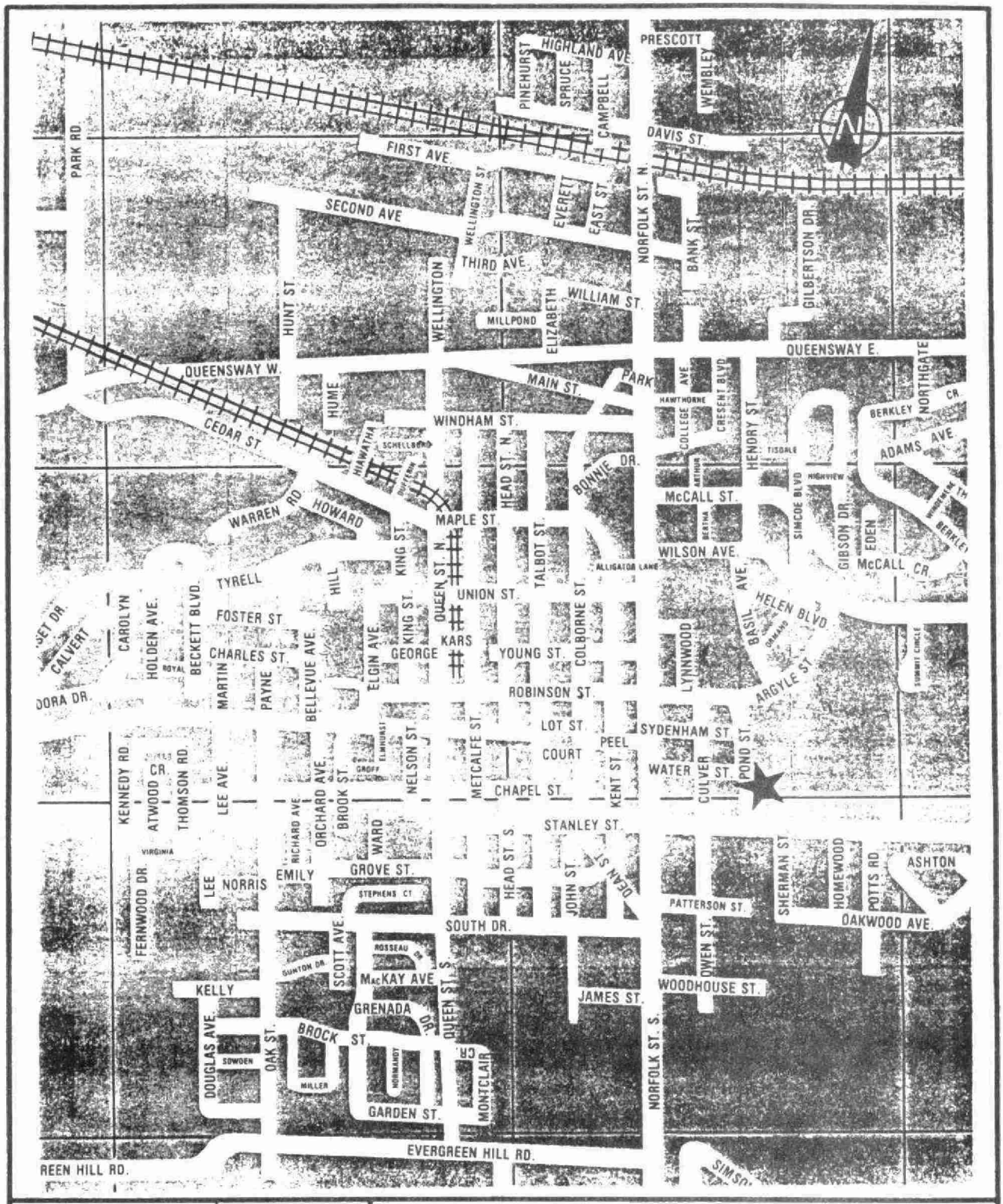
## 1.2 STUDY OBJECTIVES

The general objectives of all coal gasification plant waste site investigations in Ontario are:

- to establish the physical extent of waste, contaminated soils, sediments, surface water and groundwater on-site and off-site; and

- to identify existing impacts on public health and the environment and, where necessary, develop recommendations to mitigate or prevent these impacts.

In addition to these general objectives, the specific objectives of this investigation of the Simcoe coal gasification plant site are:

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LOCATION OF FORMER SIMCOE GAS WORKS

FIGURE 1.1

- to determine the presence and extent of coal tar waste on the plant site and between the site and the Lynn River;

- to determine whether the air quality in buildings on the site may be affected by coal tar waste that may still exist on the site; and

- to determine whether the Lynn River has been impacted by the direct seepage of coal tar wastes from the site and/or the discharge of contaminated groundwater.

## 1.3 STUDY SCOPE

To satisfy the objectives of this study INTERA KENTING developed a comprehensive work plan based on corporate experience obtained from previous coal tar site investigations. The work plan included four major tasks as follows:

- Task 1 - Preliminary Studies
- Task 2 - Determination of Extent of Contamination
- Task 3 - Impact Assessment and Development of Remedial Measures
- Task 4 - Project Reporting.

The first Task consisted of a number of tasks which provided an understanding of site conditions from available information and directed the field work. These tasks involved the review of historical maps and reports, aerial photographs, geologic maps and reports, geotechnical reports and well records. The results of this Task are described in Section 2.1 of this report.

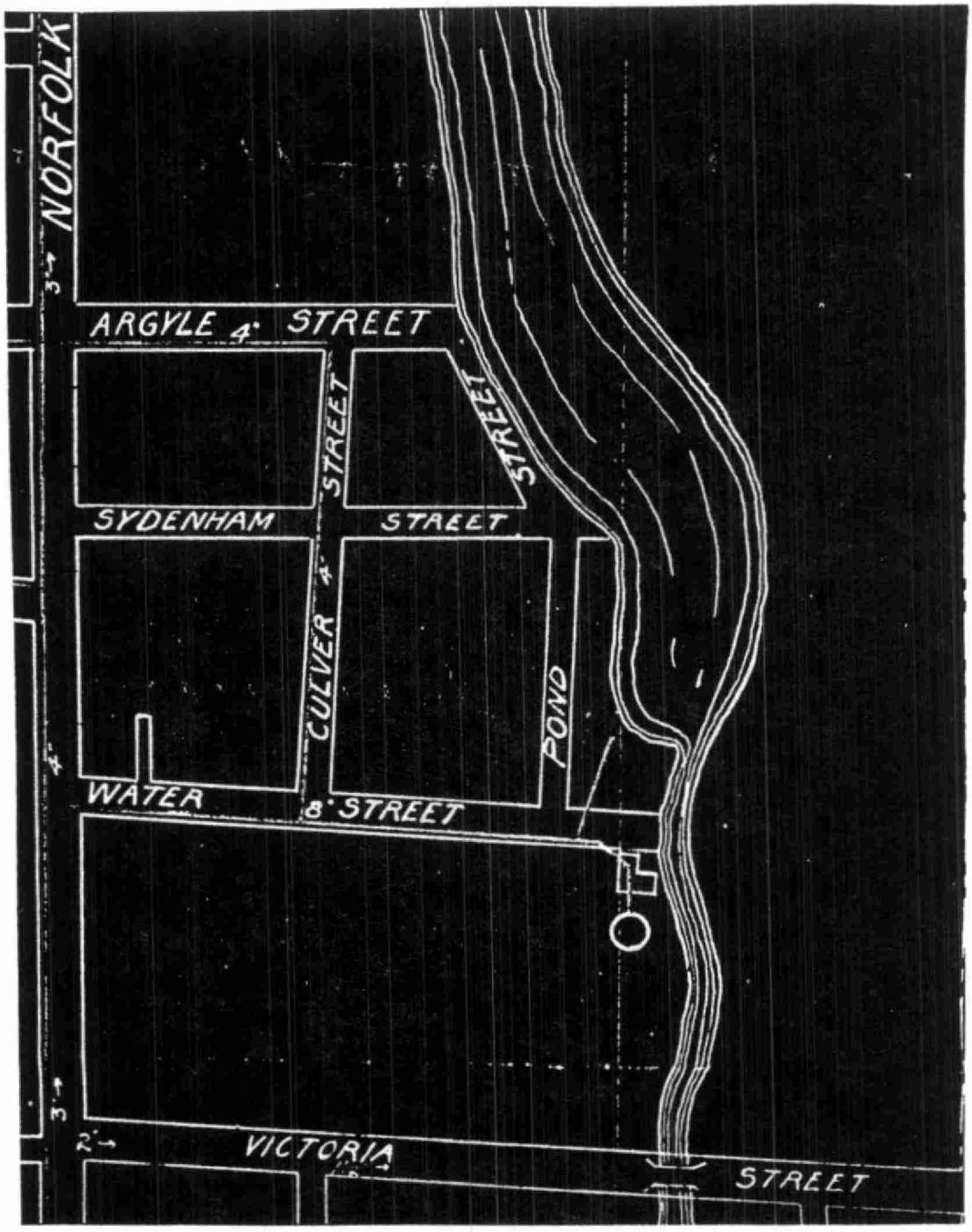
Task 2 was designed to determine the extent of coal tar waste contamination in the vicinity of the site and in the Lynn River, and consisted of detailed field work which was completed using a health and safety program (Section 2.2) that complied with the Ministry of Labour's guidelines for workers exposed to waste from decommissioned coal gasification plant sites.

Task 2 included inspection and sampling of storm sewers and catch basins (Section 2.3) and ambient air quality monitoring in the Seniors' Centre (Section 2.4). A soil vapour survey (Section 2.5) was performed as a reconnaissance investigation tool to define areas of soil contamination for subsequent drilling and monitoring well placement. Soil and groundwater samples were collected to define the extent of coal tar contamination on the site adjacent to the Lynn River (Sections 2.6, 2.7 and 2.8). The Lynn River was inspected for evidence of coal tar contamination and selected samples of the River sediment were collected to quantitatively evaluate contamination by coal tar (Section 2.8).

In Task 3 (Sections 3 and 4) the results of Task 1 and Task 2 activities were compiled and interpreted to determine the existing and potential impact to human health and the environment posed by the presence of gas plant wastes in the subsurface. The requirement for remedial measures to mitigate any major impacts are assessed in Section 5.

## 1.4 SITE DESCRIPTION

The Simcoe Gas and Water Company was authorized in 1890 to install and maintain gas mains and lines which supplied the town of Simcoe with gas. The gas manufacturing plant, machinery and gas holders were leased to Dominion Natural Gas Company in 1906 and continued to operate until about 1911. Apart from the main gas plant building which is still standing, very little is known about the location of other structures and buildings (eg. coal storage sheds) on the site. A plan which accompanies the 1906 lease agreement (Figure 1.2) shows the location of the gas plant building and a gas holder which was located to the south of the gas plant building. The plan also shows the location of a gas line running from the gas holder north beneath the building and diagonally across to an 8" gas main which ran west beneath Water Street.

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1906 PLAN OF GAS MAINS AND FACILITIES OF SIMCOE GAS WORKS

FIGURE 1.2

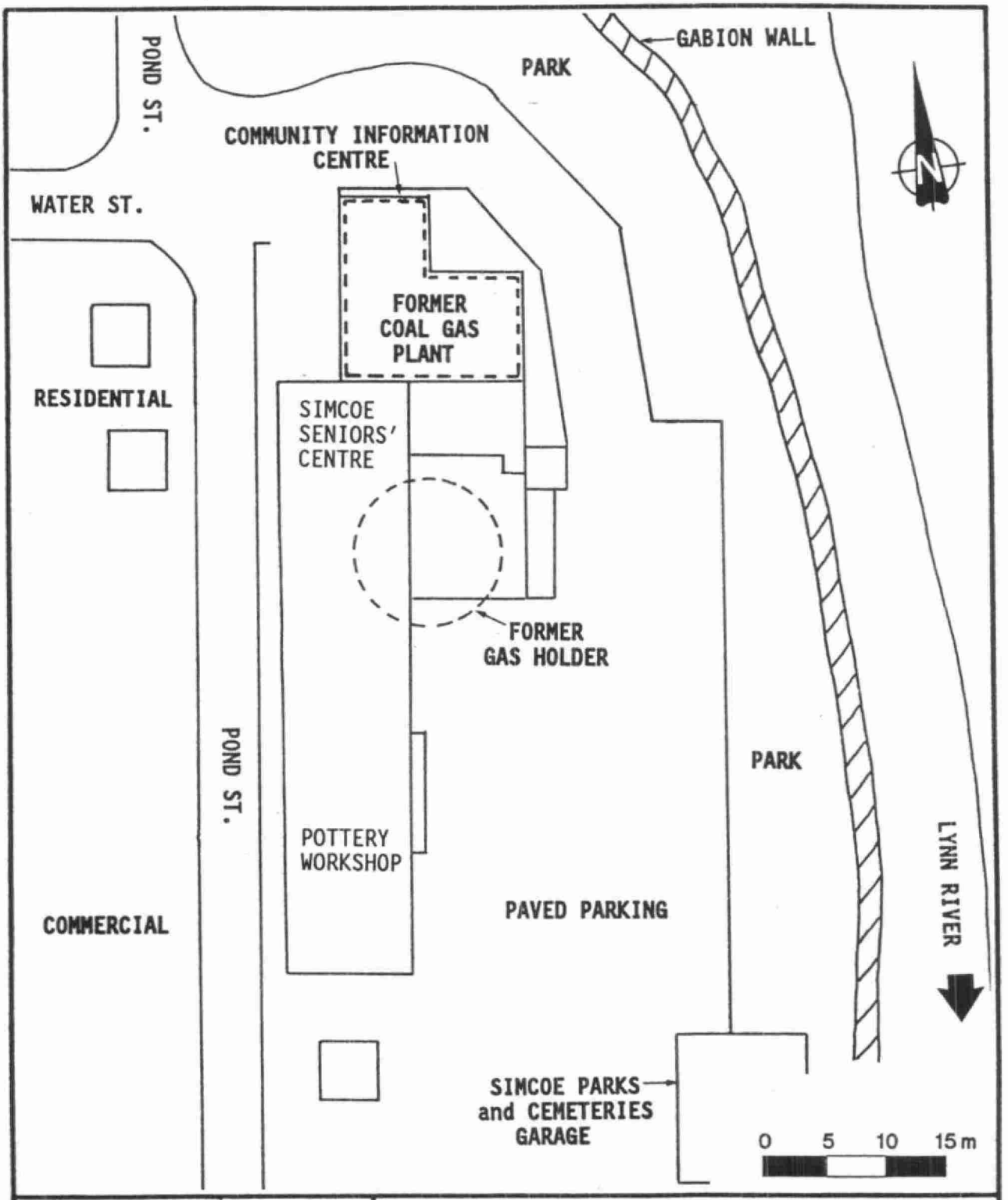
The original building which was erected in 1891, fronts onto Pond Street, and is now occupied by the Haldimand-Norfolk Information Centre. Figure 1.3 shows the former coal gasification plant structures and the current land use. The original building has undergone three phases of expansion; the first starting in 1916, was a two-storey high building, erected by the Unique Shoe Co. Ltd. and attached to the south side of the original building, and is now occupied by the Lynn River Scout Association. Two two-storey high additions added as factory space, in 1923 and 1928, by the Simcoe Mitt and Glove Co. Ltd., are currently occupied by the Simcoe Seniors' Centre and a pottery workshop respectively.

A portion of the 1916 addition and most likely part of the 1923 addition, overlie the old gas holder. As well, a portion of the gas holder is likely covered by the parking lot which lies to the east of the building, and extends about half way between the building and the Lynn River; however, there is no indication on surface as to the location of the gas holder.

Oily odours have been reported at several locations within the Seniors' Centre. Odours were particularly offensive in 1986 and led to the excavation of the floor in the Director's office. Several pipes were exposed and filled with cement. Since that time, oily odours have been noticed occasionally but have been transient rather than prolonged in nature.

The area between the parking lots and the Lynn River is occupied by greenspace and the River's bank was recontoured in 1984 when riprap placed within gabion baskets was placed along the west shore as an erosion control measure. Proposed construction of park benches, picnic tables, shuffleboard court and horseshoe court indicate the recreational importance of this site. Two 10" storm sewer outfalls discharge to the Lynn River from two catch basins set beneath the parking lot.

The site lies at the base of a gentle slope. The river level measured on April 4, 1985 indicates a vertical difference of 1.56 m between the surface of the parking lot and the Lynn River.

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EXISTING LAND USE AND FORMER GAS PLANT STRUCTURES

FIGURE 1.3

Current land use surrounding the former manufactured gas plant site includes parkland to the north and east, and residential and commercial to the west and south. Simcoe Parks and Cemeteries garage and a public utilities building are located immediately south of the site. A tire retreading facility (Simcoe Tire Service) is located northwest of the site near the southeast corner of Pond and Water Streets.

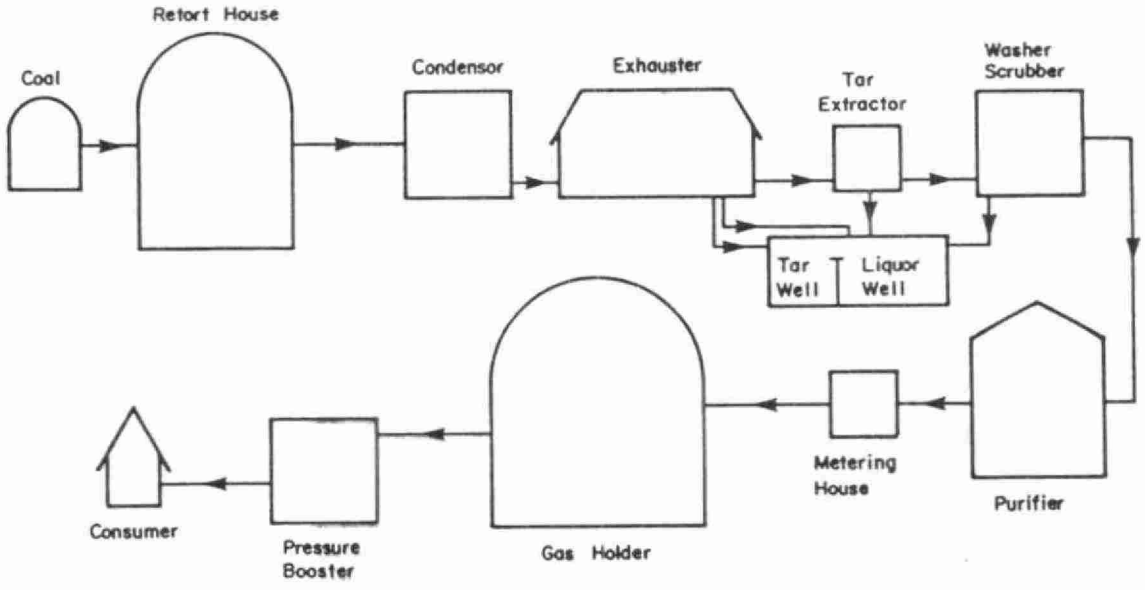
## 1.5 GENERAL CHEMISTRY, ENVIRONMENTAL BEHAVIOUR AND HEALTH EFFECTS OF COAL TAR WASTES

The most important coal gasification plant wastes from an environmental standpoint are coal tars and sludges. Coal tars and sludges are generated by the incomplete combustion of coal and coke and the recovery and condensation of the gaseous products of such combustion. The chemical and physical properties of a particular coal tar will be determined from the type of raw materials, the temperature and type of combustion and the efficiency of gas condensing, exhausting and purifying operations. At the Simcoe site, coal tars were derived from early coal carbonization facilities, likely intermittent vertical retorts. Figure 1.4 shows the material flow schematic for a typical retort gas plant.

The major organic chemicals associated with coal tars that may pose an environmental concern are:

- Polycyclic Aromatic Hydrocarbons (PAH, e.g., naphthalene, benzo(a)pyrene);
- Phenolics;
- Monocyclic Aromatic Hydrocarbons (MAH, e.g., benzene, toluene, xylenes).

These compounds are present in tars, sludges and liquors derived from coal. Table 1.1 shows the physical and chemical properties of typical coal tar constituents.

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**MATERIAL FLOW SCHEMATIC FOR A TYPICAL RETORT GAS PLANT**

**FIGURE 1.4**

Table 1.1 Physical and Chemical Properties of Typical Coal Tar Constituents

| Constituent | Formula | Molecular Weight | Aqueous Solubility (mg/L) | Log $K_{ow}$ [6] |
|---|---|---|---|---|
| PAH | | | | |
| Naphthalene | $C_{10}H_8$ | 128.16 | 31.7[1] | 3.37 |
| Acenaphthylene | $C_{12}H_8$ | 152.21 | 3.9[5] | - |
| Acenaphthene | $C_{12}H_{10}$ | 154.21 | 3.93[1] | 4.33[8] |
| Fluorene | $C_{13}H_{10}$ | 166.21 | 1.98[1] | 4.12[5] |
| Anthracene | $C_{14}H_{10}$ | 178.22 | 0.073[1] | 4.45 |
| Phenanthrene | $C_{14}H_{10}$ | 178.22 | 1.29[1] | 4.46 |
| Fluoranthene | $C_{16}H_{10}$ | 202.26 | 0.26[1] | - |
| Pyrene | $C_{16}H_{10}$ | 202.24 | 0.135[1] | 4.88[5] |
| 1,2-Benzoanthracene | $C_{18}H_{12}$ | 228.28 | 0.014[1] | 5.61[7] |
| Chrysene | $C_{18}H_{12}$ | 228.28 | 0.002[1] | 5.61[7] |
| Benzo(a)pyrene | $C_{20}H_{12}$ | 252.30 | 0.0038[1] | 6.04[7] |
| 3,4-Benzofluoranthene | $C_{20}H_{10}$ | 252.32 | 0.0015[2] | 6.7[8] |
| Benzo(ghi)perylene | $C_{22}H_{12}$ | 276.34 | 0.00026[1] | 7.23 |
| Indeno(1,2,3-cd)pyrene | $C_{22}H_{12}$ | 276.34 | 0.0002[2] | - |
| Dibenz(a,h)anthracene | $C_{22}H_{14}$ | 278.00 | 0.0005[4] | 5.97[8] |
| Light Aromatics | | | | |
| Benzene | $C_6H_6$ | 78.11 | 1780.[3] | 2.13 |
| Toluene | $C_7H_8$ | 92.13 | 538.[3] | 2.69 |
| Ethylbenzene | $C_8H_{10}$ | 106.16 | 159.[3] | 3.15 |
| Phenolics | | | | |
| Phenol | $C_6H_5OH$ | 94. | 82000.[6] | 1.46 |
| Meta-Cresol | $CH_3C_6H_5OH$ | 109. | 23500.[6] | 1.98 |

Notes:
1 Data from Mackay and Shiu (1977)
2 Data from NBS (1981)
3 Data from McAuliffe (1963)
4 Data from Pearlman et al. (1983)
5 Data from Lyman et al. (1982)
6 Data from Verschueren (1983)
7 Data from USEPA (1980)
8 Data from Versar (1979)

Polycyclic aromatic hydrocarbons are compounds consisting of two or more fused benzene rings. The physical and chemical properties of PAH are dependent on the structure of individual compounds. The aqueous solubility and volatility of each compound decreases as the molecular weight of the compound increases. Therefore those compounds with a simple structure have higher solubilities and volatilities than those with a complicated structure. In general, PAH are strongly adsorbed and immobilized in soils and are also susceptible to biodegradation by microorganisms. Table 1.1 also lists the logarithm of the octanol-water partitioning coefficient, $K_{ow}$, which is a measure of the partitioning of coal tar constituents between the water and soil. Larger $K_{ow}$ values indicate a greater affinity for adsorption. As a result of these properties, PAH tend to be relatively immobile in the environment. However, the fact that they occur in tars and that tars can migrate as immiscible, heavier-than-water or lighter-than-water phases increases their mobility and potential environmental impact.

Monocyclic aromatic hydrocarbons or light aromatics, such as benzene, xylene and toluene are moderately soluble, and biodegradable with high volatility and low sorption. They are expected to be relatively mobile in groundwater systems. However, the presence of these compounds will be largely determined by their volatility.

Phenolics (e.g., phenol, cresol and xylenol) are highly soluble with low sorption and high biodegradability and therefore are expected to be highly mobile in groundwater.

The environmental impact and risk associated with tars and tar wastes are derived from exposure and/or contact with polycyclic aromatic hydrocarbons and monocyclic aromatic hydrocarbons. The environmental impact from these substances results in adverse effects on human health and aquatic and terrestrial ecosystems. The most adverse effect associated with selected PAH and MAH is the increased incidence of cancer. Health effects associated with PAH are documented in the literature because of their ubiquitous presence in the environment. PAH are found in polluted air, tobacco smoke, cooking products, soots, tars, and oils. PAH are formed in a variety of hydrocarbon combustion processes

routinely exposing most people to very low levels of PAH. In general, PAH are a large group of chemicals of which only a few have been suitably tested with respect to human health effects. The major routes of PAH adsorption are through inhalation and cutaneous exposure (Occupational Health Program, McMaster University, 1986).

The carcinogenic activity of various PAH is given in Table 1.2. In general, the toxicity of PAH in various species increases as the molecular weight of the compound increases. This effect is tempered somewhat by differences in solubility in that heavier compounds are less soluble, and therefore, less mobile in aqueous environments. PAH are noted to bioaccumulate in animal tissue of aquatic organisms and also are accumulated by adsorption in plants.

The Canadian Council of Ministers of the Environment (CCME) (1987) recognize five-ring PAH (e.g., benzo(a)anthacene, benzo(b)flouranthene, benzo(k)flouranthene, benzo(a)pyrene, dibenz(a,h)anthracene and indeno(1,2,3 cd)pyrene) as carcinogenic.

MAH or single ringed aromatic hydrocarbons in coal tars generally consist of the hazardous compounds benzene, toluene, xylene and ethylbenzene. Of these compounds, benzene is the most hazardous because of its carcinogenic health effects (USEPA, 1980a). The common method of human exposure is by inhalation due to the volatile nature of the light aromatics.

Chronic exposure to benzene has the most serious health effects of MAH because of its increased risk for the development of leukemia (ERT, 1984). All of the MAH affect the central nervous system with acute symptoms including headache, dizziness, fatigue, nausea, unconsciousness and coma.

In aquatic ecosystems, MAH are moderately toxic to fish and lower species. Toxic levels of benzene, toluene, and xylene generally range from 1 to 100's of $mg \cdot L^{-1}$. For example, rainbow trout were found to have an LC-50 (lethal concentration for 50 percent of the population) of 5.3 $mg \cdot L^{-1}$ for benzene (USEPA, 1980a).

Table 1.2 Carcinogenic Activity of Some Unsubstituted Polycyclic Aromatic Hydrocarbons (ERT, 1983)

| | |
|---|---|
| Acenaphthylene | - |
| Anthanthrene | - |
| Anthracene | - |
| Benzo[a]naphthacene | - |
| Benzo[a]pyrene | + (c,d) |
| Benzo[a]fluorene | - |
| Benzo[b]chrysene | - |
| Benzo[b]fluoranthene | + (c,d) |
| Benzo[b]fluorene | - |
| Benzo[c]chrysene | + |
| Benzo[c]fluorene | - |
| Benzo[c]phenanthrene | + |
| Benzo[e]pyrene | - |
| Benzo[g]chrysene | + |
| Benzo[ghi]fluoranthene | - |
| Benzo[ghi]perylene | + |
| Benzo[j]fluoranthene | + (c) |
| Benzo[k]fluoranthene | - |
| Benz[a]anthracene | + (c,d) |
| Chrysene | + (c) |
| Coronene | - |
| Dibenzo[a,e]pyrene | + (c,d) |
| Dibenzo[a,h]pyrene | + (c,d) |
| Dibenzo[a,i]pyrene | + (c,d) |
| Dibenzo[a,j]naphthacene | - |
| Dibenzo[a,l]pyrene | + |
| Dibenzo[b,g]phenanthrene | - |
| Dibenzo[b,k]chrysene | - |
| Dibenzo[de,qr]naphthacene | - |
| Dibenzo[e,l]pyrene | - |
| Dibenz[a,c]anthracene | + |
| Dibenz[a,h]anthracene | + (c,d) |
| Dibenz[a,j]anthracene | + |
| Fluoranthene | - |
| Fluorene | - |
| Hexacene | - |
| Indeno[1,2,3-cd]pyrene | + (c,d) |
| Naphthacene | - |
| Naphthalene | - |
| Naphtho[2,3-b]pyrene | + |
| Pentacene | - |
| Pentaphene | - |
| Perylene | - |
| Phenanthrene | - |
| Picene | - |
| Pyrene | - |
| Tribenzo[aei]pyrene | + |
| Triphenylene | - |

[a]Data from Shear, 1938, 1941; Arcos and Argus, 1974; Dipple, 1976; Santodonato et al., 1981

[b]Symbols: + complete carcinogen by either skin painting, subcutaneous injection, intramuscular injection, intravenous injection, intraperitoneal injection, intratracheal instillation, oral administration to mammals
- negative in animal bioassay

[c]Compounds classified as "having substantial evidence of carcinogenicity" by the U.S. EPA Carcinogen Assessment Group (U.S. EPA, 1980b). The CAG list also includes two alkylated PAH (7, 12-dimethylbenz(a)anthracene and 3-methylcholanthrene), as well as "coal tar and soot", "coke oven emissions (polycyclic organic matter)" and "creosote".

[d]Compounds classified as showing "sufficient evidence" of carcinogenicity for animal carcinogens by the International Agency for Research on Cancer.

A recent Ontario Ministry of Labour sponsored study, (Occupational Health Program, McMaster University, 1986) provides a comprehensive review of the available scientific evidence relating to health effects of coal tar and other substances which contain polynuclear aromatic hydrocarbons. This study concludes that there is sufficient evidence concerning human carcinogenic potential of coal tar products in the literature to warrant stringent control of workplace exposures. This study recommends an interim standard for occupational exposure to volatiles of coal tar products at 0.05 $mg/m^3$ (cyclohexane soluble extract) time weighted over an 8 hour working day and zero dermal exposure.

# 2. SITE INVESTIGATIONS

## 2.1 REVIEW OF EXISTING INFORMATION

Prior to the start of any field work, the existing information for the site was collected, compiled and reviewed. This compilation and review included historical maps and reports, aerial photographs, geologic maps and reports, geotechnical data and well records.

Historical data for the Simcoe coal gasification plant is available at the Eva Brook Donly Museum but is limited to:

- 1890 Instrument 74879 Deed of Land to the Simcoe Gas and Water Company;
- 1890 Town of Simcoe By-Law 216 authorizing Simcoe Gas and Water Company to lay down water and gas distribution pipes;
- 1905 Town of Simcoe By-Law No. 381 granting Dominion Natural Gas Co. Ltd. rights and privileges to sell and distribute natural gas within Town of Simcoe;
- 1906 Lease of Simcoe Gas and Water Company Ltd. facilities to Dominion Natural Gas Co. Ltd.;
- 1913 Town of Simcoe By-Law No. 617 authorizing sale of gas distribution system of Simcoe Gas and Water Co. Ltd. to Dominion Natural Gas Co. Ltd.
- 1917 Town of Simcoe By-Law No. 688 providing amendments to By-Law No. 381.

The only available historical map for the site is a gas main map appended to the 1906 lease agreement which is in part reproduced as Figure 1.2 in this report.

Review of these historic documents and other information contained within the inventory report suggests that the Simcoe gas works operated from about 1891 to about 1905. In 1905, natural gas was available in Norfolk County and in the 1906 lease there is reference to the demised gas manufacturing apparatus. Although natural gas was available to the Town of Simcoe cal906, the supply was likely variable and not dependable, and the 1906 lease required that the Dominion Natural Gas Co. Ltd. maintain "machinery and apparatus used in the manufacture of artificial gas". Although the 1913 By-Law No. 617 makes reference to the right of Dominion Natural Gas Company to manufacture, supply and distribute gas in Simcoe, it is unlikely that the manufactured gas facilities operated at this date. Consequently, the likely maximum operating period was 1891-cal911 or about twenty years.

Historical air photos were reviewed at the National Air Photo Library, Ottawa, and at the University of Toronto and Ministry of Natural Resources air photo libraries. No useful historical air photos were found as coverage was available only for as early as 1945.

Some engineering and technical information is available regarding soils, building foundations, road works, utility lines and renovation to the west park of Lynn River. Shallow geotechnical boreholes completed along Water St. and Sydenham St. indicate a stratigraphy consisting of sandy silt to sandy gravel. These borehole logs also indicate the presence of an organic (peat) layer within the top 0.8 m of the subsurface. A hydrocarbon odour was detected at 1-2 m depth in a sandy gravel horizon of a geotechnical borehole completed on the south side of Water Street approximately 200 m west of the site. However this is not likely related to contaminant migration from the gas works as it is located hydraulically upgradient from the gas works site.

There also appears to have been little downgradient migration of separate phase coal tar to the Lynn River as the 1984 renovation of the west bank of the Lynn River by the Long Point Regional Conservation Authority did not reportedly expose coal tar wastes.

Regional geologic and hydrogeologic information for the Simcoe gas works is available from geologic reports, city piezometers installed along Water and Sydenham Streets, Environment Ontario water well records and hydrogeologic reports for the municipal water supply wells. The available geologic information (Barnett, 1978; 1982; Ontario Geological Survey, 1984) indicates that the Town of Simcoe is underlain by a buried sand and gravel delta deposit formed from a glacial meltwater channel. This 3 - 18 m thick sand and gravel unit is overlain by 1.5 - 9 m of glaciolacustrine sand, silt and clay. The available hydrogeologic information from water well records, City piezometers and the municipal water supply wells (Pitts and Sobanski, 1972) indicate regional groundwater flow within permeable unconfined sands and gravels which in the area of the gas works is directed to the southeast toward Lynn River.

## 2.2 HEALTH AND SAFETY PLAN

All field work at the Simcoe site was conducted under a health and safety plan (HSP) which was fully compliant with the Ministry of Labour's "Occupational Health Protocols for Workers Exposed to Waste from Coal Gasification Plant Sites". These guidelines have been used by INTERA KENTING at several other coal tar sites in Ontario.

In addition to the Ministry of Labour protocols, INTERA KENTING implemented special HSP procedures outlined in the following sections.

### 2.2.1 Air Monitoring

Air monitoring was performed as part of site investigations to monitor and control emissions resulting from the exposure of waste materials and to assist in implementing the health and safety program. Air monitoring at the Simcoe site was implemented on a real-time basis using a hand-held organic vapour meter (OVM). The OVM has a photoionization detector for detecting organic vapours with a detection limit of 0.1 ppm. The use of real-time measurements allowed for the immediate implementation of emission control measures when a potentially hazardous condition was indicated by the OVM. Where there was a potential for a hazardous condition, all field workers were required to wear

half-face respirators with organic vapour/acid gas cartridges until monitoring indicated a safe condition.

Monitoring of air quality with the OVM was routinely measured two-three times per day at the site during the field operations and more frequently (1 hour interval) during drilling and soil sampling activities. During drilling and soil sampling, monitoring was performed at the well head, in the drillers breathing space and upwind and downwind of the drilling area. Although some elevated levels of organic vapours were detected at the well head, the monitoring showed that at no time was the ambient air quality at the site impacted by the site investigations. At all times the OVM readings downwind of the work area were equal to background concentrations of about 1 ppm total organic vapours.

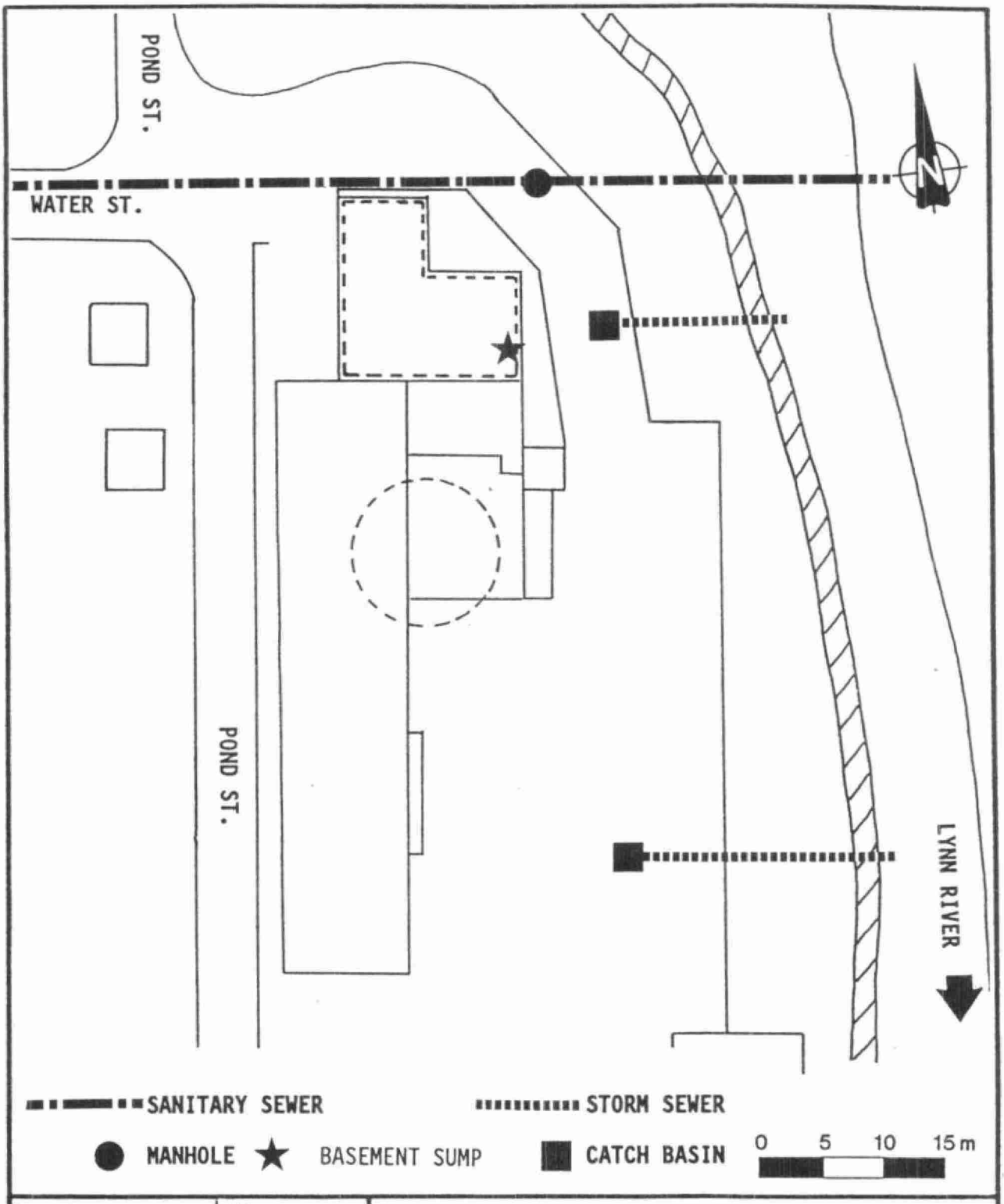
Hazardous conditions in the on-site work areas were defined as organic vapour contents greater than 5 ppm above background as measured by the OVM or by the presence of noxious odours. At no time were such hazardous conditions measured in the on-site work areas.

### 2.2.2 Equipment Decontamination

All field equipment that came in contact with tar or waste material was decontaminated. Decontamination procedures consisted of methyl hydrate followed by distilled water rinses where appropriate. All sampling and monitoring equipment including soil samplers, drilling equipment (augers, rods, etc.) well materials (pipe and screen) water sampling materials and associated equipment were decontaminated after use at a borehole or well to prevent cross-contamination between sampling points. All wash waters were flushed to the sanitary sewer.

## 2.3 INSPECTION AND SAMPLING OF STORM SEWERS

Storm sewers in the area of the former gas plant were inspected and sampled for evidence of coal tar contamination. The storm water drainage network and associated catch basins, building sumps and outfalls in the study area are shown in Figure 2.1 from data obtained from the Town of Simcoe Public Works

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STORM WATER CATCH BASINS, SEWERS AND SUMPS

FIGURE 2.1

Department. These sewers include the two catch basins that drain from the on-site parking lot to the Lynn River and the building sump in the basement of the Seniors' Centre.

All catch basins and the building sump identified in Figure 2.1 were inspected for evidence of coal tar contamination. This inspection included removal of the catch basin or sump grate, inspection of walls of the catch basin for evidence of tar seepage, monitoring or organic vapour contents within the catch basin or sump, disturbance of basin sediment and observations of any resulting sheens on the water surface. Where possible water and sediments samples were collected for visual and olfactory inspection of coal tar wastes.

No coal tar odours or coal tar was observed in any of the catchbasins or the building sump. Only low organic vapours at the instrument detection limit (1 ppm) were measured in the catchbasins and sump. Minor oily sheens were observed in the two catch basins located in the parking lot and in the building sump. The oily sheens in the parking lot catch basins are likely caused by runoff of oil and grease from the parking lot. Some paint was found in the north catch basin. Oily sheens were observed on standing water in the basement beneath the pottery workshop, but no oily odours were noted. Source of this sheen is unknown.

## 2.4 AMBIENT AIR QUALITY TESTING

Impact of coal tar waste on air quality inside buildings of the former Simcoe gas works is central to this investigation, particularly in light of the odour complaints previously reported in the Senior's Centre.

Ambient air quality sampling was performed on May 1 and 2, 1990 within the Director's office of the Seniors' Centre, within the basement of former gas plant building, and outside the building beside the Lynn River. Ambient air quality sampling was performed using low volume sampling pumps that passed a continuous stream of ambient air through a sorbent tube. The sampling and analysis of ambient air was performed in accordance with National Institute for Occupational Safety and Health (NIOSH) (1984) Method 1501 for aromatic

hydrocarbons. Air samples were collected over sampling periods of 40-219 minutes. Only the volatile components of coal tar were analyzed in the air samples as these components are most likely to create an air quality impact. Air quality parameters analyzed included MAH compounds of benzene, toluene, o-xylene, m & p-xylene and ethlybenzene and the PAH compound of naphthalene. Appendix A summarizes the laboratory analytical results. These results are presented in Table 2.1 as concentrations of MAH and PAH compounds in ambient air.

Table 2.1 shows that no MAH or PAH were detected in the air quality samples collected during this investigation.

## 2.5 SOIL VAPOUR SURVEY

A soil vapour survey was performed at the site of the former Simcoe gas works and some surrounding property on May 1-3, 1990. The survey was performed using a Thermo Electron Model 590 OVM/GC. The organic vapour meter (OVM) of this OVM/GC has a photoionization detector for the measurement of organic vapour concentrations in the range of 0.1-2000 ppm. The soil vapour survey was a reconnaissance investigation tool used to define the presence of coal tar wastes in the subsurface for subsequent drilling, soil sampling and well installation.

Soil vapour samples were collected from both outside the existing on-site buildings and from the basement of the old gas works building. Soil vapour samples were collected outside of the existing buildings by driving 12.7 mm galvanized pipe to depth of 1 m using a fence post slide hammer. A 95 mm carriage bolt was inserted into the pipe tip to act as a drive point and to prevent plugging of the pipe. At the desired depth of 1.0 m, a 32 mm polyethylene tube was inserted into the pipe, sealed at the top with a rubber stopper and attached to the OVM. The drive pipe was then pulled back 0.1 m allowing the carriage bolt to slip out and expose the inside of the pipe and the polyethylene tubing to soil-gas. A self contained electric pump in the OVM was used to draw soil vapour through the detector and soil-gas concentrations were read from a digital readout.

Table 2.1 Results of Ambient Air Quality Testing* in $mg/m^3$

| Air Quality Parameter | Seniors Centre Directors Office Sample No. 1, 2 | Basement of Information Centre Sample No. 3, 4 | Beside Lynn River Sample No. 5, 6 |
|---|---|---|---|
| Benzene | <2.2 | <2.5 | <2.4 |
| Toluene | <1.1 | <1.2 | <1.2 |
| O-Xylene | <1.1 | <1.2 | <1.2 |
| M&P-Xylene | <1.1 | <1.2 | <1.2 |
| Ethylbenzene | <1.1 | <1.2 | <1.2 |
| Naphthalene | <0.05 | <0.04 | <0.05 |

* Sampling and Analysis following NIOSH Method 1501

Soil vapour measurements were made at 59 locations around the existing buildings adjacent to Lynn River and north and west of the gas works site. These locations and the results expressed as total organic vapour are shown in Figure 2.2. As shown in Figure 2.2, only two elevated soil vapour readings were detected - 5 ppm adjacent to the River opposite the south end of the Senior's Centre and 51 ppm 7 m northwest of the former gas works building. The 51 ppm measurement was subsequently shown by further measurements to be an isolated pocket of organic vapour.

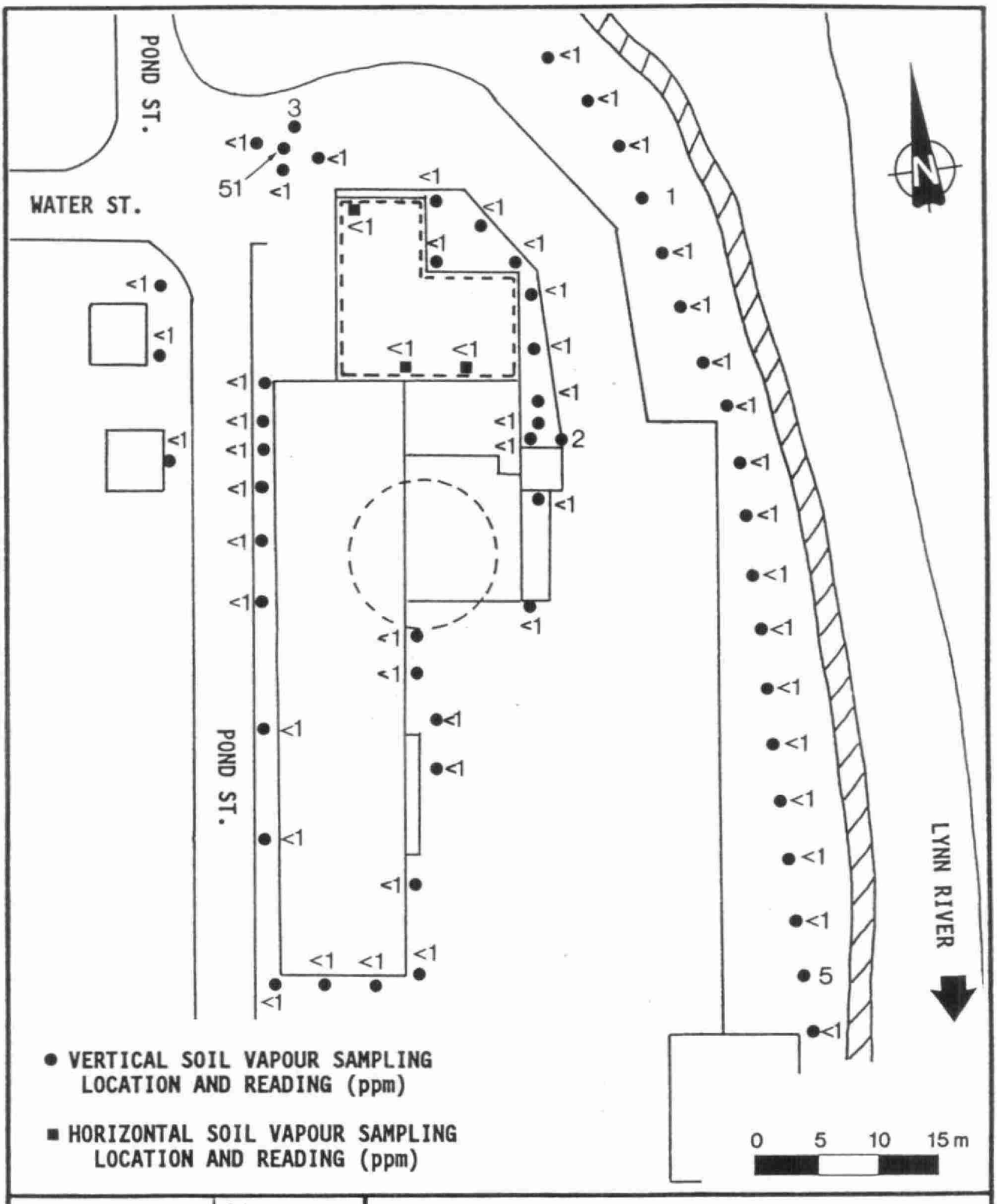
In addition to the vapour measurements shown in Figure 2.2, three measurements were also made at distances of 30 m, 40 m and 50 m north of the gas works building near the River. These results were all <1.0 ppm.

Soil vapour samples were also collected from the basement of the old gas works building by driving similar sampling pipes horizontally through cracks in basement wall. Soil vapour measurements were made from the north and south sides of the basement walls. Samples collected through the south basement wall were in the direction of the former gas holder. Only background soil vapour concentrations (i.e., < 1 ppm) were measured from the basement of the old gas works building.

## 2.6 DRILLING, SOIL SAMPLING AND WELL INSTALLATION

Ten boreholes were drilled as part of this study to investigate the subsurface soil and groundwater conditions. The locations of these boreholes are shown on Figure 2.3. Drilling, soil sampling and monitoring well installation were performed using a truck-mounted soil auger rig with hollow stem augers.

Soil sampling was performed continuously in each borehole using split spoons which were thoroughly cleaned before use. Each soil sample was logged for stratigraphy, in terms of soil type, grain size, texture and structure. In addition to logging for stratigraphy each soil rock sample was examined for visual or olfactory evidence of contamination. An organic vapour meter was also

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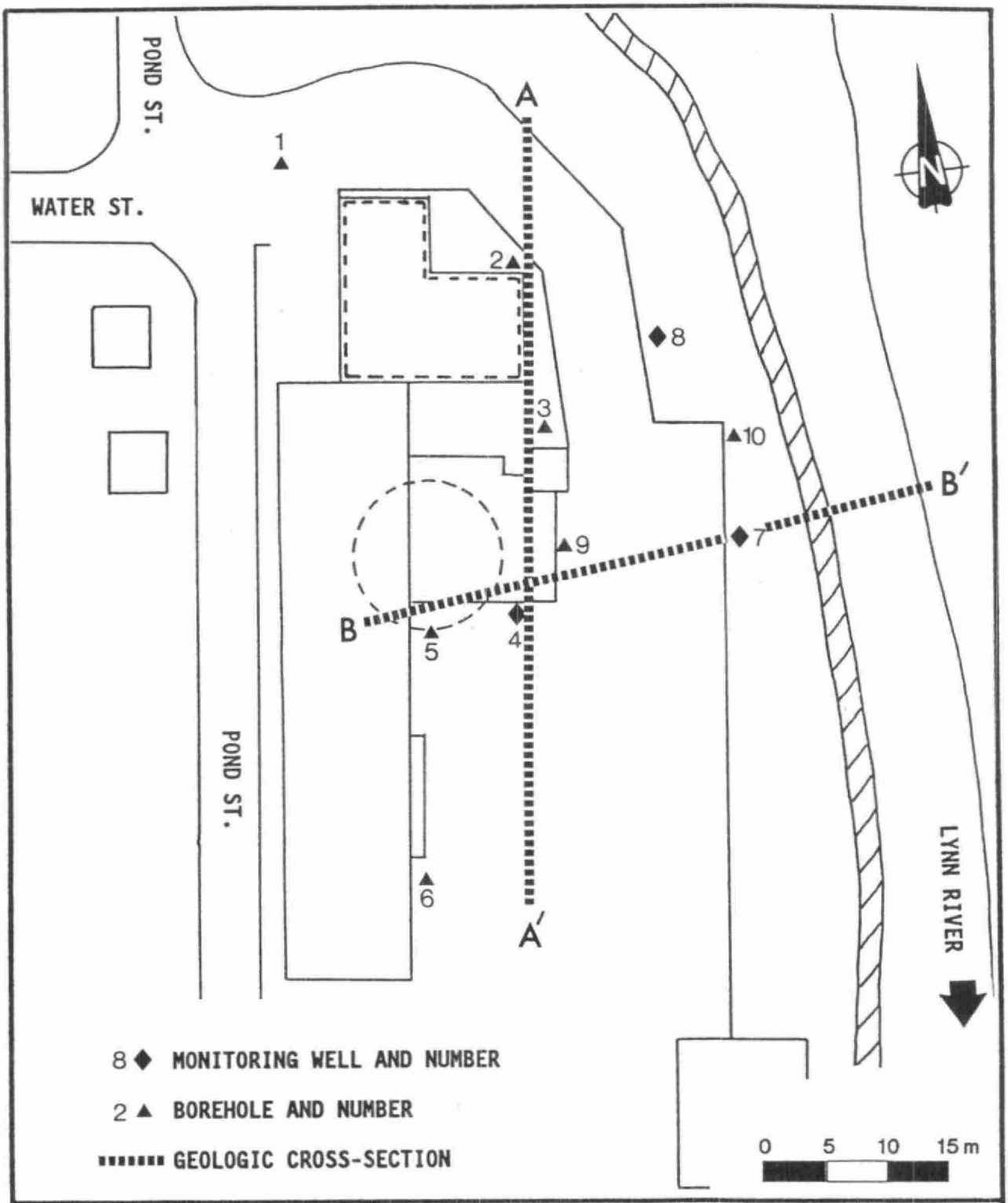
RESULTS OF SOIL VAPOUR SURVEY

FIGURE 2.2

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LOCATION OF BOREHOLES, MONITORING WELLS AND GEOLOGIC CROSS SECTIONS

FIGURE 2.3

used to quantify the extent of coal tar contamination in each sample. After logging, each soil sample or rock core was bagged or bottled, labelled and retained for future reference. All information regarding soil stratigraphy, structure, evidence of odours or tar waste was identified on borehole logs which are given in Appendix B.

Visual evidence of coal tar contaminants in the form of a purple or blue oily sheen on soil samples and augers was observed during completion of boreholes 3, 8 and 9. Coal tar odours were also detected during drilling of boreholes 2, 3, 7, 8 and 9. The highest OVM readings were measured in boreholes 5 and 9 at 8 ppm. No free product coal tar as residual saturation, as dispersed ganglia or as pools was detected during the drilling program.

The majority of boreholes drilled in this study intersected 1.5 - 3.0 m of fill overlying 0-1 m of dark brown/black peat overlying 2.5 - 5.0 m of glaciolacustrine sand and silt. The fill unit consisted of brick, sand, gravel, ash, cinder and other debris. All evidence of coal tar contamination was found at the bottom of the fill unit, within the organic peat layer and in a coarse sand unit underlying the peat layer.

A coal tar contaminated soil sample was collected from the fill and peat unit in BH-8 and analyzed for Reg 309 leachate benzo(a)pyrene (B(a)P) to determine disposal requirements for any future excavation at the site. The B(a)P concentrations in the leachate were 101 - 125 ng/g which indicates that the soil, if excavated, would be considered registerable non-hazardous waste and should be disposed at an appropriate landfill as waste class 222N.

After soil sampling, boreholes 4, 7, and 8 were completed as monitoring wells for the purpose of providing water level measurements and groundwater samples. At each well location, one 1.5 m length, 51 mm diameter PVC well screen and flush-threaded PVC pipe was placed at the bottom of the borehole (typically against the peat and sand unit) and sand-packed into place using a silica sand if necessary. A 2 m thick bentonite clay seal was placed above the sand or natural material to surface. A protective casing with locking cap was placed

around the standpipe at surface. Table 2.2 summarizes the details of the monitoring well installations.

After installation, each well was developed by surging with a surge block and purged of three well volumes prior to groundwater sampling. The purge water was collected at surface and discharged to the sanitary sewer.

## 2.7 MINIATURE PIEZOMETER INSTALLATION

Four small diameter piezometers were installed in the Lynn River to assess the quality of the groundwater discharge to the River from the former gas works site. These piezometers were installed to depths of 1.5 m below River level and 1.2 m below the bottom of the River at the locations shown in Figure 2.4. A steel pipe and post pounder were used to set the piezometers about 1.0 m from the River's edge. The piezometers consisted of 13 mm diameter polyethylene tube and 0.3 m of nylon well screen.

Miniature piezometers were selected as the most appropriate method to determine the dissolved contaminant loading to the River from contaminated groundwater at the gas works site. Direct sampling of the Lynn River water was deemed not to be useful in assessing loading to the River because of the low solubility and strong sorption of PAH and the volatility of MAH in surface waters.

## 2.8 GROUNDWATER TESTING, SAMPLING AND MONITORING

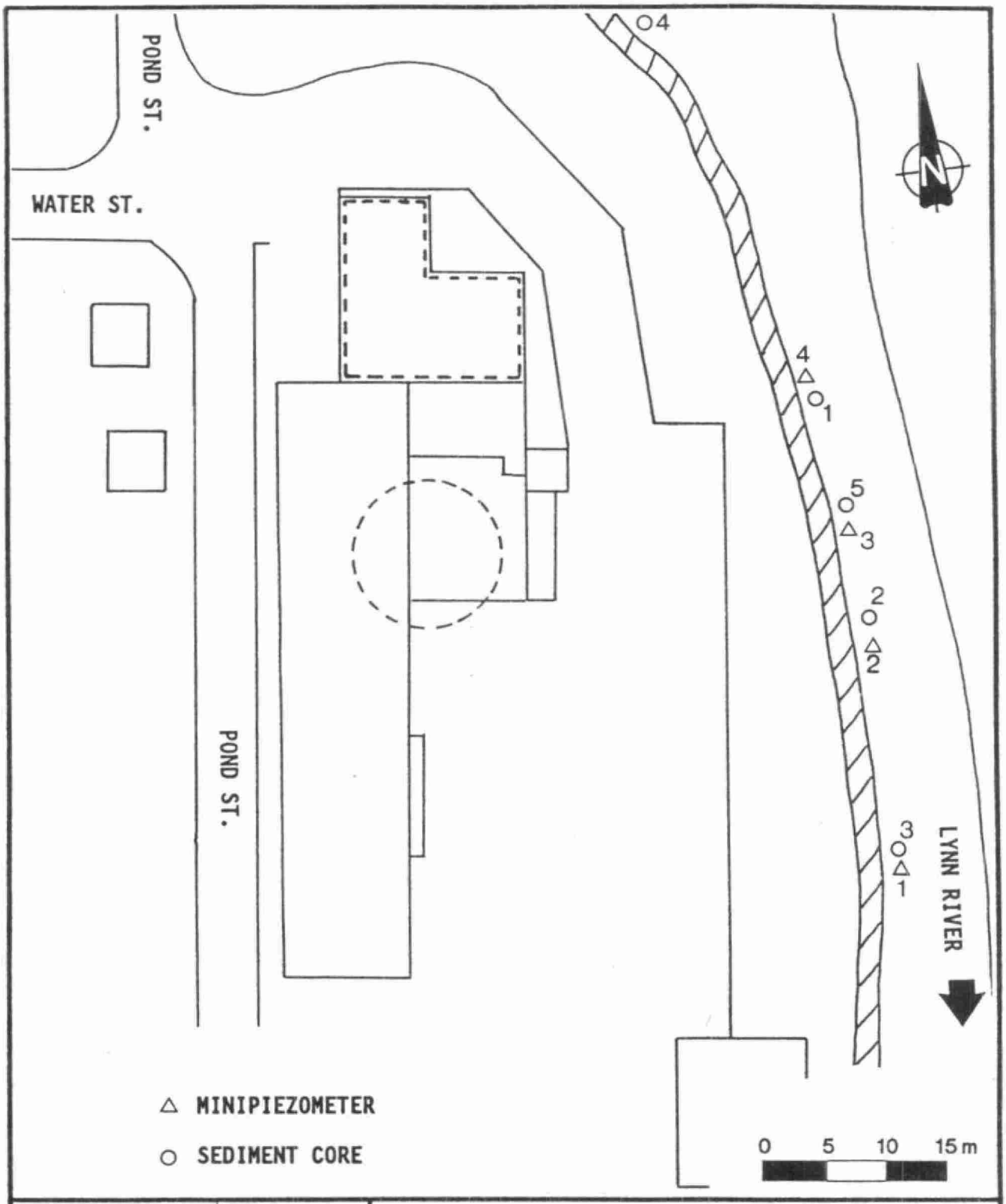
Monitoring wells 4, 7 and 8 were hydraulically tested to determine the hydraulic conductivity of formation opposite the screened interval. Each monitoring well was initially slug tested and the responses were analyzed using the Hvorslev (1951) method. In this method the recovery of the water level to equilibrium conditions is normalized and plotted on a semi-logarthmic plot and the time ($T_o$) to reach 63% recovery of head is used to determine hydraulic conductivity by the equation:

Table 2.2 Well Installation Details

TABLE 2.2 WELL INSTALLATION DETAILS
FORMER GAS PLANT SIMCOE, ONTARIO

| Well Number | Top of Well Casing Elevation (m AMSL) | Ground Surface Elevation (m AMSL) | Bottom of Hole (m BGS) | Bottom of Screen (m BGS) | Top of Screen and Bottom of Seal (m BGS) | Top of Seal (m BGS) |
|---|---|---|---|---|---|---|
| BH-4 | 208.77 | 208.05 | 5.03 | 5.03 | 1.83 | 0.00 |
| BH-7 | 208.30 | 207.66 | 5.03 | 5.03 | 2.13 | 0.00 |
| BH-8 | 208.40 | 207.80 | 5.03 | 4.11 | 2.13 | 0.00 |

NOTES:
(1) All elevations w.r.t. Benchmark No. 72-U-325 (Elev. 210.878 m) located at the corner of Water and Culver Streets.
(2) m AMSL = meters above mean sea level
(3) m BGS = meters below ground surface

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LOCATION OF MINIATURE PIEZOMETERS AND SEDIMENT CORES IN LYNN RIVER

FIGURE 2.4

$$K = \frac{r^2 \ln (L/R)}{2 L T_o} \quad (1)$$

where: K = hydraulic conductivity (m/s);
r = casing radius (m);
R = radius of sandpack or borehole (m);
L = effective thickness of formation or screen length (m);
$T_o$ = time to achieve 65% head recovery from slug (s).

The responses in monitoring wells 4 and 7 were too rapid to be analyzed by the Hvorslev method and only test results for monitoring well 8 were useful. The water level recovery plots for these tests are given in Appendix D.

Monitoring wells 4 and 7 were subject to low volume, constant discharge pumping tests. During these tests the measured drawdown rapidly approached a steady state value and the formation hydraulic conductivity was calculated from the equation:

$$K = \frac{Q}{\Delta H 2 \pi L} \ln (L/R) \quad (2)$$

where: Q is steady state flowrate ($m^3/s$);
$\Delta H$ is steady state drawdown (m);

and other parameters are as previously defined. Wells 4 and 7 were each tested at two different flowrates.

Table 2.3 summarizes the results of the hydraulic testing and shows that the shallow soils at the site are permeable with hydraulic conductivity of $1 \times 10^{-5}$ m/s - $2 \times 10^{-4}$ m/s.

# Table 2.3 Hydraulic Test Results

TABLE 2.3 HYDRAULIC TEST RESULTS
FORMER GAS PLANT SIMCOE, ONTARIO

| WELL ID AND TEST NO. | HORIZON MATERIAL | WELL RADIUS (m) | SCREEN LENGTH (m) | To (sec) | FLOW RATE Q (L/sec) | DRAW DOWN H (m) | HYDRAULIC COND. K (m/sec) | |
|---|---|---|---|---|---|---|---|---|
| BH-4-1 | PEAT & COARSE SAND | 0.0968 | 3.20 | - | 0.025 | 0.025 | 2E-04 | * |
| BH-4-2 | PEAT & COARSE SAND | 0.0968 | 3.20 | - | 0.247 | 0.390 | 1E-04 | * |
| BH-7-1 | SANDY FILL & COARSE SAND | 0.0968 | 2.90 | - | 0.023 | 0.035 | 2E-04 | * |
| BH-7-2 | SANDY FILL & COARSE SAND | 0.0968 | 2.90 | - | 0.250 | 0.420 | 1E-04 | * |
| BH-8-1 | PEAT, SAND & SILT | 0.0968 | 1.98 | 38.4 | - | - | 1E-05 | ** |
| BH-8-2 | PEAT, SAND & SILT | 0.0968 | 1.98 | 40.8 | - | - | 1E-05 | ** |

* Hydraulic conductivity calculated using the Constant Head Permeability Test as defined by the Bureau de Normalisation du Quebec, Standard No.: NQ 2501-135 (86/03/11)

** Hydraulic conductivity calculated using standard Hvorslev Method

The three monitoring wells and four miniature piezometers were sampled for analysis of water quality parameters indicative of coal tar contamination. Water samples were collected after purging each well or piezometer of three well or piezometer volumes. Purging and subsequent sampling were performed using dedicated "Waterra" inertial hand pumps or clean lengths of 6.4 mm polyethylene tubing and a peristaltic pump. During pumping, measurements of water pH, temperature and electrical conductivity were made at the well head using appropriate electrodes and meters. Table 2.4 summarizes the stable readings of these parameters at the time of groundwater sampling as well as for surface water of the Lynn River. After stabilization of these field geochemical parameters, water samples were collected in the following quantities and in the following sample containers.

PAH - 1 L amber glass bottle
MAH - 1 100 mL amber glass septum vial.

Groundwater samples were collected unfiltered and immediately stored at 4°C and shipped the same day to Novalab Ltd. in Lachine, Quebec. Samples were shipped in ice chests by a reputable courier.

Groundwater sampling and analysis were conducted under a quality assurance/quality control program that included established sampling protocols and quality control samples. Established sampling protocols included the use of dedicated sampling equipment, non-contaminating sampling equipment, sample identification and labelling, sampling record logs, and chain of custody records. Quality control samples included the use of trip blanks for MAH and PAH analysis, the use of laboratory blanks and the use of surrogate standards on each PAH analysis.

Appendix E summarizes the MAH and PAH analyses of groundwater at the Simcoe site. MAH and PAH concentrations were determined by GC/MS analysis. These results show that only low levels of specific MAH (i.e., benzene - 9.2 µg/L; ethylbenzene - 1.1 -11.2 µg/L; toluene - 4.2 - 13 µg/L; and other aromatic hydrocarbons - 1.4 - 4.9 µg/L) were present in the collected samples.

Table 2.4 Field Geochemical Measurements

| Well/ Minipiezometer | pH | Temperature °C | Conductivity µmhos/cm |
|---|---|---|---|
| BH-4 | 7.7 | 11.6 | 1190 |
| BH-7 | 7.8 | 12.2 | 1380 |
| BH-8 | 9.0 | 9.8 | 1600 |
| MP-1 | 7.1 | 12.4 | 770 |
| MP-2 | 7.2 | 12.3 | 1280 |
| MP-3 | 7.2 | 12.6 | 1060 |
| MP-4 | 6.8 | 11.7 | 2320 |
| Lynn River Water | 8.0 | 13.2 | 430 |

The low levels of toluene are thought to be derived from the sampling tubing and the low levels of benzene, ethylbenzene and other aromatic hydrocarbons are likely related to residual gas plant wastes.

The PAH analysis show trace to very low levels of PAH in groundwater samples collected from all four miniature piezometers and from monitoring well 4. Total priority PAH concentrations in these samples ranged from 0.05 µg/L (MP-3) to 0.54 µg/L (MP-2). However because low levels of naphthalene were detected in the trip blank and MP-1 and MP-3 samples, waters from MP-1 and MP-3 can be considered essentially free of priority PAH.

Higher levels of PAH were detected in water samples collected from monitoring wells 7 and 8. Total priority PAH concentrations in these samples were 10.1 µg/L (BH-7) and 252 µg/L (BH-8). The highest individual priority PAH concentrations were in the sample from BH-8 with phenanthrene - 99 µg/L, acenaphthene - 82 µg/L, fluorene 36 µg/L and anthracene 15 µg/L. Trace to low levels of some five-ring carcinogenic PAH were detected in samples from BH-7 and BH-8.

After the completion of groundwater sampling, a water level monitoring program was established to determine the equilibrium fluid levels in the monitoring wells and minipiezometers as well as in selected City piezometers located northwest of the site. Water levels were measured with respect to the top of the well casing or minipiezometer tube. These elevations were referenced to town of Simcoe datum. Water levels were measured on May 3, 1990 and are shown in Table 2.5 as elevations in meters Above Mean Sea Level (m AMSL).

## 2.9 LYNN RIVER INVESTIGATION

Sediment samples were collected from the Lynn River to assess the presence of coal tar wastes in the River sediments. Figure 2.4 shows the location of the five sediment samples. Sediment samples were collected by driving a 0.6 m length, stainless-steel split spoon 0.7 to 0.8 m into the river bottom. Split spoons were appropriately cleaned between samplings. Recovered

## Table 2.5 Water Level Summary

TABLE 2.5 WATER LEVEL SUMMARY
FORMER GAS PLANT SIMCOE, ONTARIO

| Well Number | Top of Well Casing Elevation (m AMSL) | Ground Surface Elevation (m AMSL) | Water Level Measured May 3/90 (m BTC) | Water Level Elevation May 3/90 (m AMSL) |
|---|---|---|---|---|
| **Monitoring Wells** | | | | |
| BH-4 | 208.77 | 208.05 | 2.42 | 206.35 |
| BH-7 | 208.30 | 207.66 | 2.10 | 206.20 |
| BH-8 | 208.39 | 207.79 | 2.48 | 205.91 |
| **Mini Piezometers** | | | | |
| MP-1 | 206.16 | - | 0.14 | 206.03 |
| MP-2 | 206.07 | - | 0.09 | 205.98 |
| MP-3 | 206.16 | - | 0.34 | 205.83 |
| MP-4 | 206.01 | - | 0.18 | 205.83 |
| **City Piezometers (NW of Site)** | | | | |
| CP-3 | 211.39 | - | 2.91 | 208.48 |
| CP-4 | 211.40 | - | 3.41 | 207.99 |
| CP-5 | 210.94 | - | 3.10 | 207.84 |
| CP-6 | 210.43 | - | 3.24 | 207.19 |
| **River Level** | | | | |
| AT MP-1 | - | - | - | 205.79 |
| AT MP-2 | - | - | - | - |
| AT MP-3 | - | - | - | 205.82 |
| AT MP-4 | - | - | - | 205.82 |

All elevations w.r.t. Benchmark No. 72-U-325 (Elev. 210.878 m) located at corner of Water and Culver Streets.
m AMSL = meters above mean sea level
m BTC = meters below top of casing

samples were inspected for visual and olfactory evidence of coal tar contamination and tested for organic vapour content with the OVM. Samples were placed in 500 mL glass jars with foil-lined lids. Sediment samples 1, 2, 3 and 5 were collected adjacent to the former gas works site. Sediment sample 4 was an upstream sample collected about 40 upstream from the gas works and 40 m downstream from the dam.

All sediment samples did not show any visual, olfactory or organic vapour evidence of coal tar.

Sediment samples 1, 4 and 5 were placed in an ice chest and shipped to Novalab Ltd. for laboratory GC/MS analysis of priority PAH. Appendix F summarizes these laboratory analytical results.

The analyses show the presence of low levels of most intermediate to heavy molecular weight priority PAH in all three sediment samples. Total priority PAH concentrations were 6.5 µg/L (Sed. 1), 6.3 µg/g (Sed. 4), 12.7 µg/g (Sed. 5). All sediment samples also contain low levels (<1 µg/g) of carcinogenic five-ring PAH.

# 3. INTERPRETATION OF RESULTS

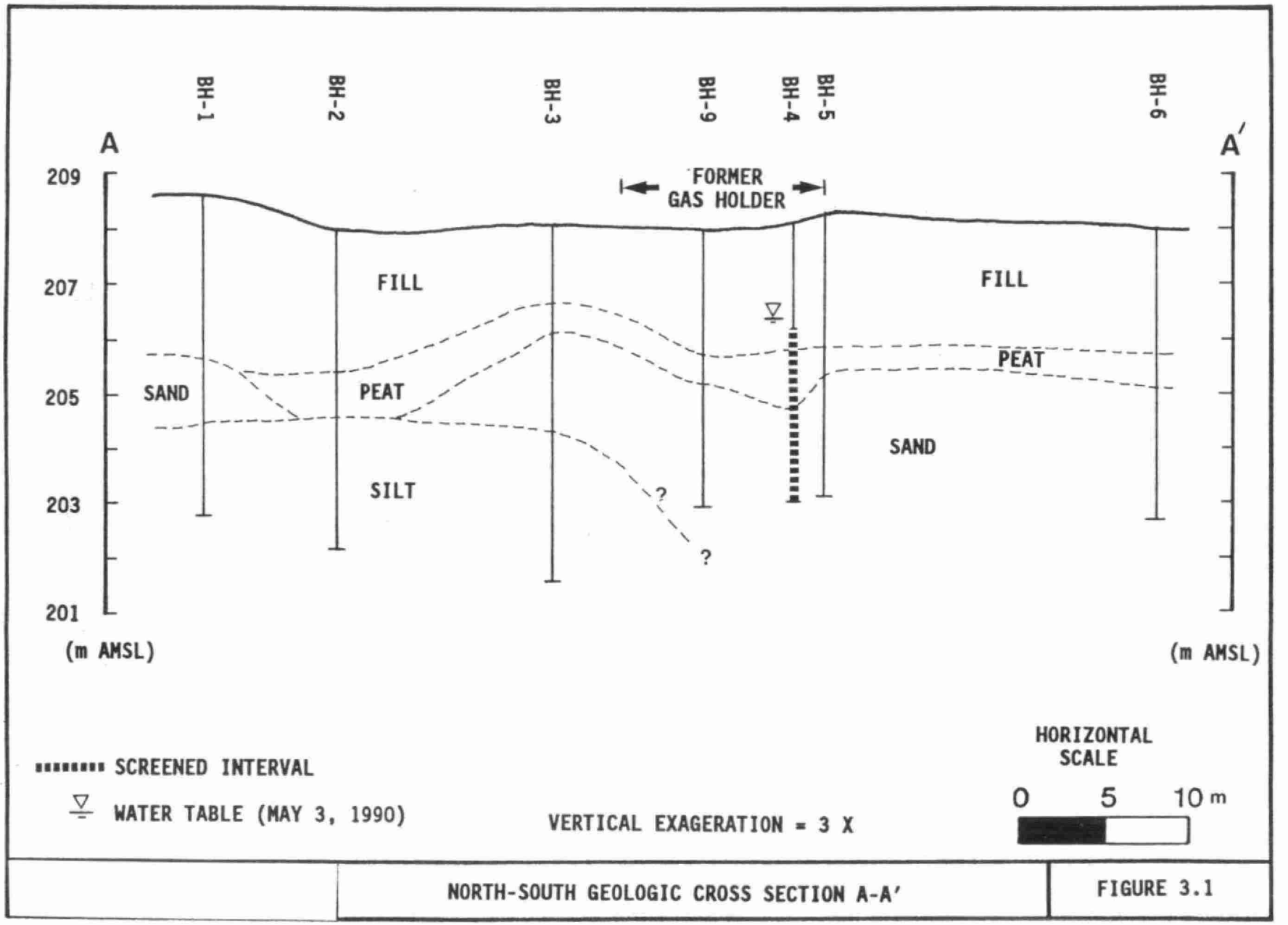
## 3.1 SITE GEOLOGY

The regional geology of the Simcoe area as discussed in Section 2.1 consists of a buried sand and gravel deposit formed by a glacial meltwater channel. This 3-18 m thick sand and gravel unit is overlain by 1.5 - 9 m of glaciolacustrine sand, silt and clay. This glaciolacustrine deposit is the shallow stratigraphic unit at the former gas works site.

The local geology of the former gas works site as determined from borehole investigations is illustrated in two geologic cross-sections, the lines of which are shown in Figure 2.3. Figure 3.1 shows the north-south (A-A') geologic cross-section and Figure 3.2 shows the west-east (B-B') geologic cross section. The north-south cross-section is constructed perpendicular to local groundwater flow and the west-east cross section is constructed parallel to the local groundwater flow.

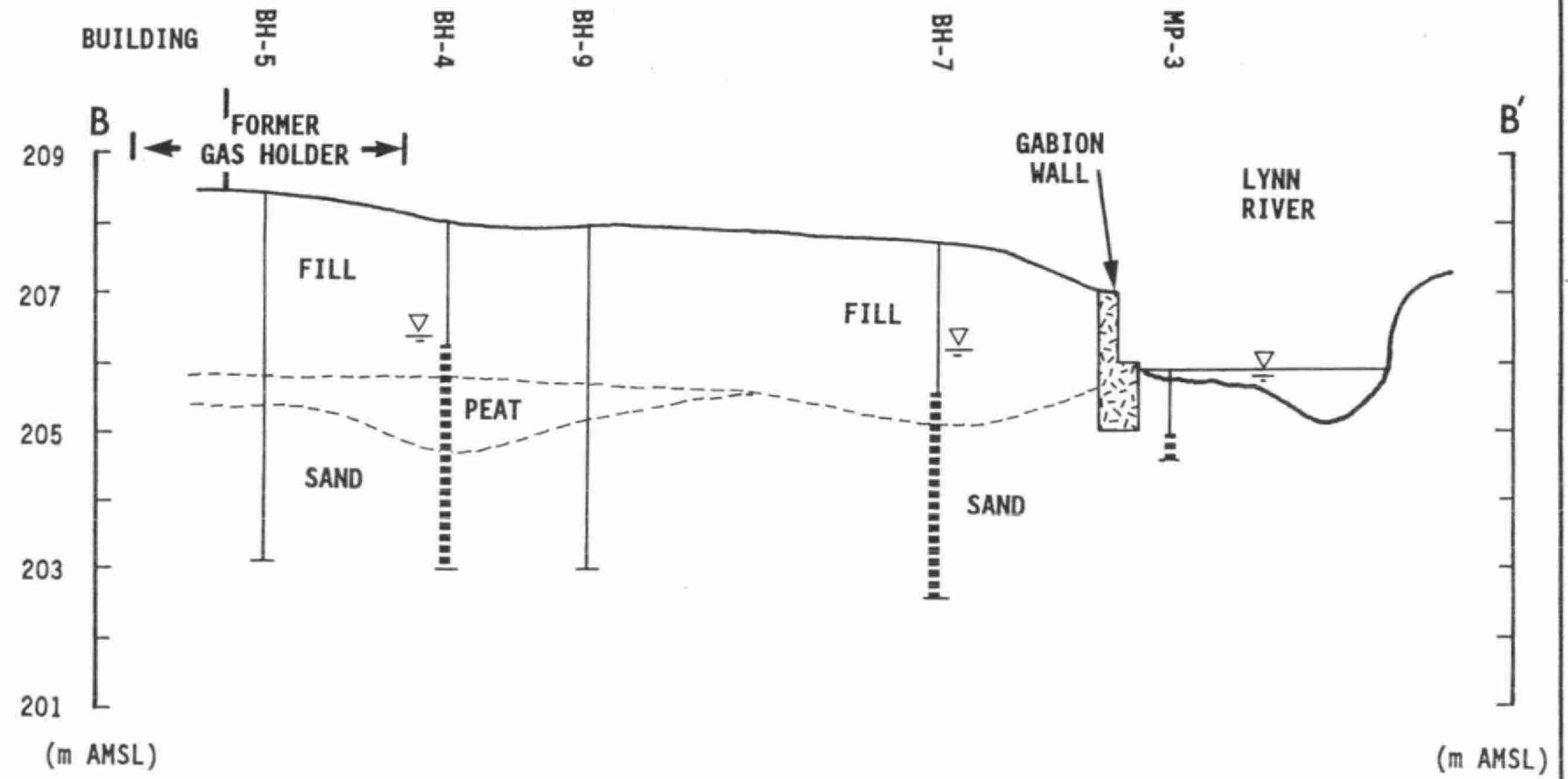
Figures 3.1 and 3.2 show the local stratigraphy as fill overlying a discontinuous peat layer overlying sand and silt. Over the northeast part of the site in the area of BH 1, 2, 3, 8 and 10 a silt layer underlies the fill, peat and sand. In this area, the sand unit also thins to the northeast from about 2 m thickness at BH-3 to 1 m at BH-1 and BH-8 to 0 m at BH-2 and 10.

The silt unit and the peat unit are both important geologic units in evaluating contaminant distribution and migration at the site. The shallow peat layer because of its depth and high percentage of organic materials is a natural sink for dissolved organic chemicals in groundwater such as PAH and MAH that may be residual at gas works sites. The silt layer because of its fine grained composition and therefore high capillary pressures is a natural barrier to the migration of dense immiscible liquids such as coal tar. The silt layer if present over the southern half of the site would be found below elevations of 203 m or depths of 5.5 m.




NORTH-SOUTH GEOLOGIC CROSS SECTION A-A'

FIGURE 3.1




WEST-EAST GEOLOGIC CROSS SECTION B-B'

FIGURE 3.2

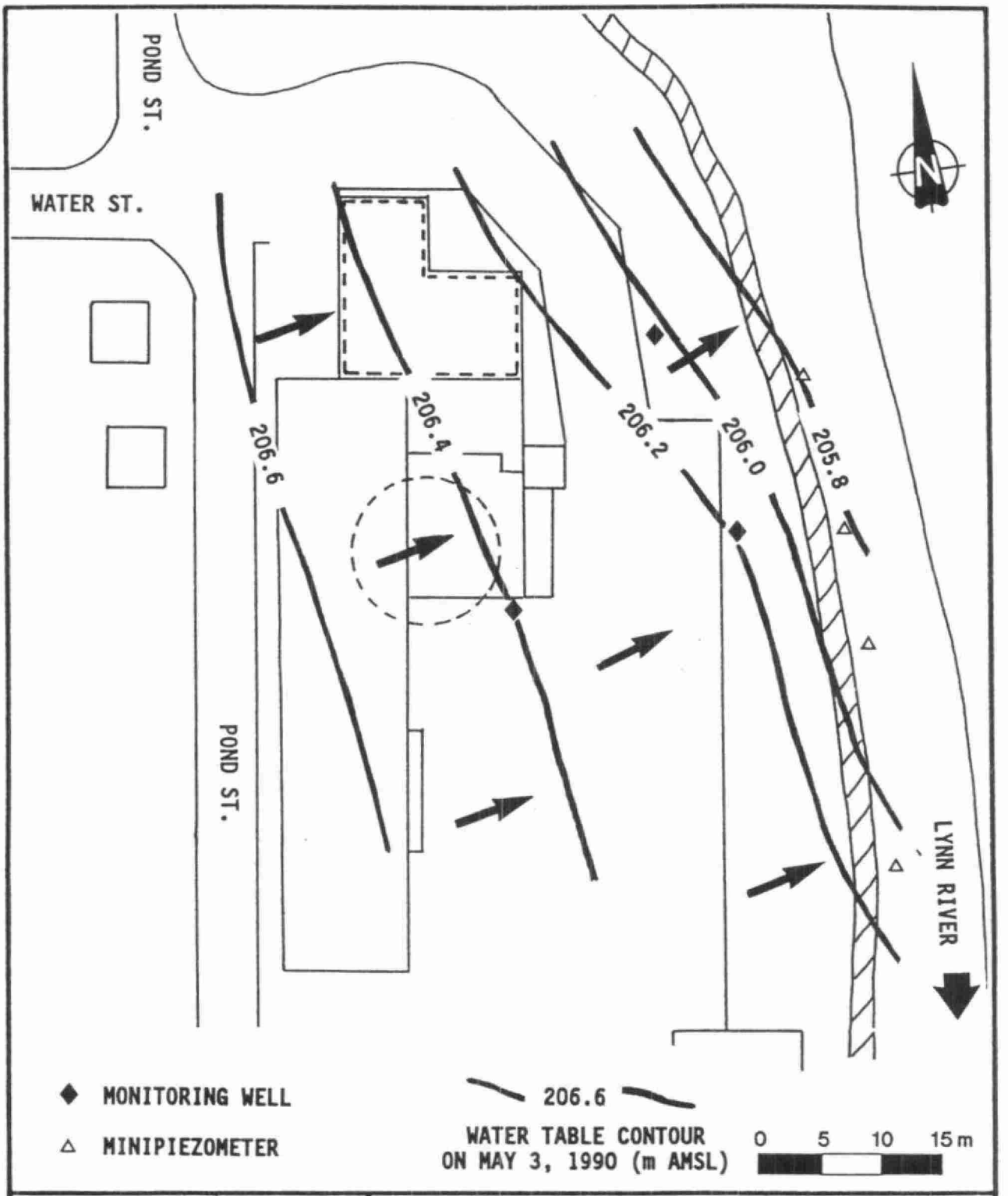
## 3.2 HYDROGEOLOGY

The hydrogeology of the former Simcoe gas works is relatively simple consisting of unconfined permeable deposits of fill, peat and sand overlying a less permeable silt unit. The water table is found within the fill unit and slopes to the east north-east across the site to the Lynn River. Figure 3.3 shows the contoured water level information for the upper hydrostratigraphic unit of fill, peat and sand as determined from monitoring wells, miniature piezometers and some nearby City piezometers on May 3, 1990. Little hydrogeologic information is available concerning the extent and hydraulic properties of the lower hydrostratigraphic silt unit. The silt unit is presumed to be of lower hydraulic conductivity than the overlying sand, peat and fill units.

Groundwater flow at this site occurs from the west south-west to east north-east with average hydraulic gradients of about 0.02 m/m between the former gas works buildings and the Lynn River. This shallow unconfined groundwater system is recharged by vertical infiltration through the permeable fill unit both on- site and off-site. On-site groundwater in this shallow system principally discharges to the Lynn River although a small component also likely discharges to the building sump during periods of high groundwater levels.

The horizontal flow of groundwater across the former gas works site to the Lynn River can be estimated using Darcy's Law from the calculated average hydraulic gradient (0.02 m/m) and an estimate of the horizontal hydraulic conductivity of the soil determined from hydraulic tests. The geometric mean of the available hydraulic conductivity results is $6 \times 10^{-5}$ m/s. Multiplying the hydraulic gradient times the hydraulic conductivity gives a horizontal flowrate of $1.2 \times 10^{-6}$ $m^3/s$ per unit area of flow.

To calculate an average discharge rate of groundwater to the Lynn River from the site it is necessary to approximate the area of horizontal flow. Assuming a 3 m depth and 40 m width of horizontal groundwater flow, the calculated total flux to the Lynn River from the gas works site would be $1.4 \times 10^{-4}$ $m^3/s$ or 8 L/min. Given the uncertainty and range in calculated

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WATER TABLE CONTOURS AND INTERPRETED GROUNDWATER FLOW DIRECTIONS

FIGURE 3.3

hydraulic conductivity, these estimates are considered to be only order of magnitude correct and therefore total groundwater discharge to the Lynn River from the site should be considered as a few liters per minute.

## 3.3 EXTENT AND MIGRATION OF CONTAMINATION

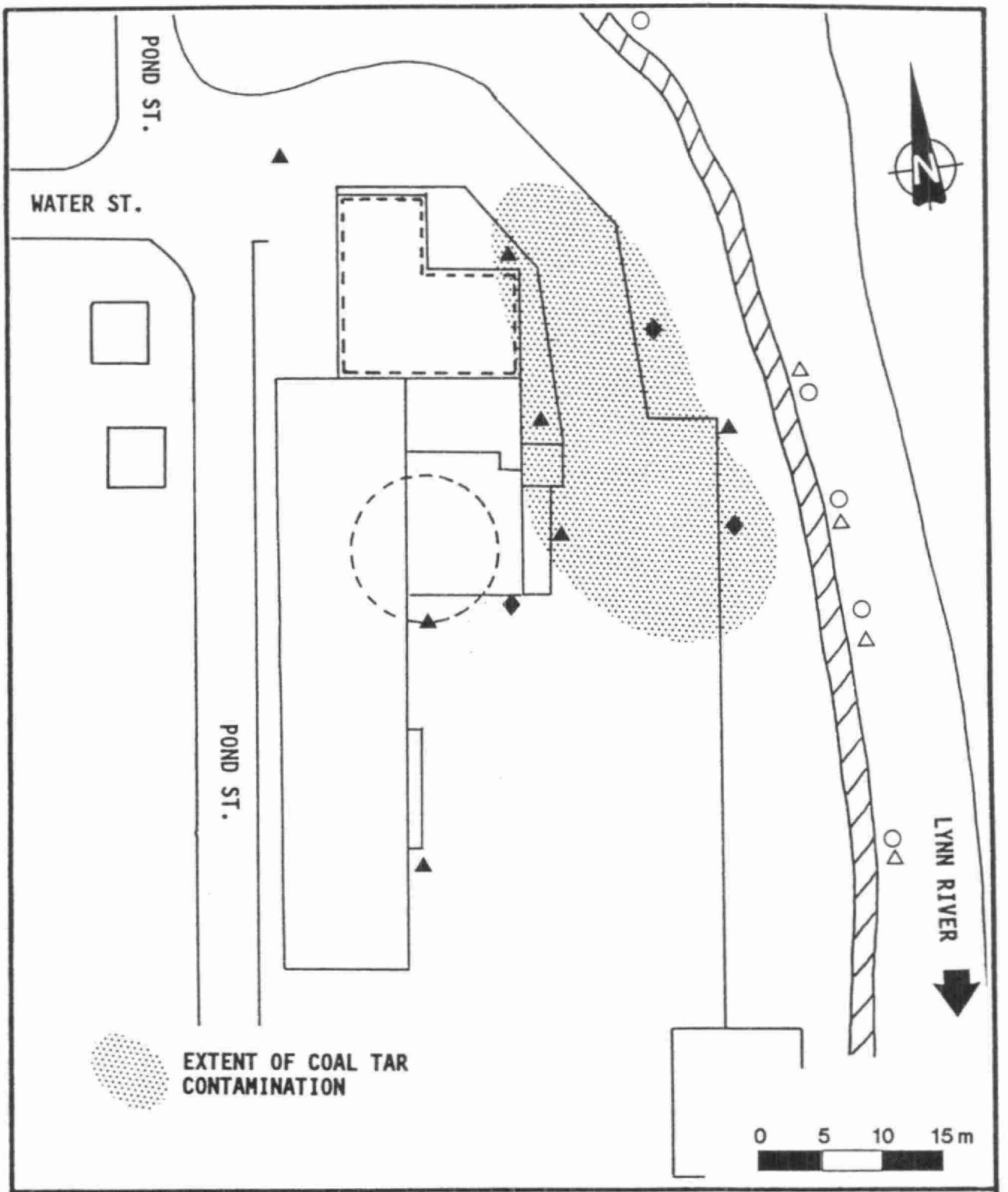
### 3.3.1 Soil and Sediment

Soil and sediment sampling performed in this investigation did not indicate the presence of separate-phase coal tar in either on-site soils or Lynn River sediments. However visual and olfactory inspection and organic vapour measurements indicated the presence of residual coal tar contamination in parts of the fill, peat and sand units at the site. The extent of these on-site contaminated soils are shown in Figure 3.4. Figure 3.4 defines a 15 m x 40 m area that extends east from the former gas works building and gas holder toward the Lynn River.

Sediment samples from the Lynn River did not show any visual, olfactory or organic vapour evidence of coal tar contamination. Low levels of total priority PAH of 6.3 µg/g to 12.7 µg/g were measured in submitted samples. However because similar levels were measured in the upgradient samples and the samples adjacent to the former gas works site, these results are inconclusive with respect to coal tar loading to the Lynn River from the former gas works site. It is of interest however that the sediment sample from opposite the former gas holder and closest to the area of contamination shown in Figure 3.4 showed the highest total priority PAH concentrations of the analyzed sediment samples. However these PAH levels are very low and may be attributed to other sources than the gas works (i.e., runoff of vehicle exhaust, petroleum products from roads and parking lots).

### 3.3.2 Groundwater

The available groundwater quality data indicated groundwater contamination only in monitoring wells 7 and 8 and possibly in MP-2. Interpreting similar groundwater conditions for similar soil conditions the

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EXTENT OF COAL TAR CONTAMINATION

FIGURE 3.4

extent of groundwater contamination by coal tar wastes is therefore also shown in Figure 3.4 as the shaded area. Groundwater in this area is therefore characterized by trace to low levels of selected MAH and PAH.

Groundwater collected from the miniature piezometers located down gradient from the shaded area identified in Figure 3.4 show only very low levels of selected light- to intermediate-molecular weight PAH. The measured concentrations may be related to migration of dissolved coal tar wastes to the Lynn River, however the levels are so low as to not be reliable or environmentally significant.

### 3.3.3 Ambient Air

Air quality sampling was performed to quantify the presence or absence of volatile coal tar waste compounds in the ambient air of the Senior's Centre, in the basement of the Information Centre and outside in the parking lot adjacent to the Lynn River. No MAH or volatile PAH compounds characteristic of coal tar wastes were detected in the collected samples.

# 4. IMPACT ASSESSMENT

This section assesses the impacts on the public and the environment based on the site and environmental conditions described in Section 3.

Based on these conditions, it is appropriate in assessing human health impact to consider the exposure route of inhalation of airborne contaminants at the site and specifically within the existing buildings. In assessing environmental impacts it is appropriate to consider the Lynn River as the important environmental receptor and migration and loading of coal tar wastes to the River by groundwater flow as the migration pathway.

## 4.1 HUMAN HEALTH

Some minor residual coal tar and contaminated groundwater exist at the site and therefore the principal exposure route for impact on human health is inhalation of volatile components of coal tar wastes. There is no groundwater use in the area of the site and therefore there is no human health impact from consumption of contaminated groundwater. Also there is no free product coal tar and therefore direct contact with coal tar is not a health concern.

Air quality monitoring was performed during the drilling operations and within the on-site buildings. The air quality monitoring during drilling showed no degradation of air quality during the site investigations. Air quality monitoring in the Director's office of the Seniors Centre, in the basement of Information Centre and outside adjacent to the Lynn River showed non-detectable levels of BTEX and naphthalene.

The detection limits for benzene of 2.2 - 2.5 $mg/m^3$ are lower than the 1971 Ontario Environmental Protection Act standard of 10 $mg/m^3$. However this standard is currently under revision and a more stringent standard is anticipated. U.S. time-weighted averages for 8 hour exposure for benzene are 30 $mg/m^3$ for a threshold limit value and 10 $mg/m^3$ for a permissible exposure limit and are consistent with other international standards. The Ontario Ministry of Labour standard for time weighted average exposure under the

Occupational Health and Safety Act is 16 mg/$m^3$. Air quality protection parameters for toluene and xylene have been established by MOE Air Resources Branch at 2.0 and 2.3 mg/$m^3$ respectively, based on an odour standard. Detection limits for toluene and xylene were 1.1-1.2 mg/$m^3$.

No naphthalene was detected at the site at detection limits of 0.04 - 0.05 mg/$m^3$. MOE Air Resources Branch guidelines for 0.5 h averaged exposure of individual PAH are available only for benzo(a)pyrene at 0.003 µg/$m^3$ and naphthalene at 0.036 mg/$m^3$.

The available air quality analyses show that the air quality within and outside of the on-site buildings and generally at the site have not been impacted by contaminants derived from coal tar or other gas plant wastes. Therefore there is no current impact on human health at the site posed by the existence of the former gas works. This conclusion is consistent with the observation that there was no free product coal tar remnant at the site today.

## 4.2 ENVIRONMENT

The principal environmental receptor for the former Simcoe gas works is the Lynn River. Migration and loading of dissolved coal tar contaminants from the site to the river are considered.

As described in Section 3.3, a zone of coal tar contaminated soil and groundwater exists between the former gas works and the Lynn River. The Lynn River may potentially be impacted by flow of contaminated groundwater from this zone. However, the levels of MAH and PAH detected in groundwater within this zone of coal tar contamination are only at trace to low levels. Consequently, MAH and PAH loading to the Lynn River from the gas works site are negligible.

This negligible loading can be demonstrated through some simple loading calculations and the water quality results from the miniature piezometers. The total groundwater flow to the Lynn River from the site is estimated at about 8 L/min which is about 0.004% of the estimated River flow rate of 200 $m^3$/min.

Consequently, any detectable levels of MAH or PAH that may discharge to the river would be at such a low concentration in the River as to be of no significance.

The water quality results from the miniature piezometers demonstrate more directly that there is negligible loading of PAH and MAH to the Lynn River from the former gas works site today.

Lynn River sediments provide an indication of historic loading of PAH and MAH to the River from groundwater and surface water flow. Because only very low levels of PAH were found in the collected sediment samples, and there was no significant increase between samples collected upstream and opposite the site, there is no conclusive evidence that there has been historic loading to the River sediments from the gas works site.

## 5. SITE REMEDIATION

The results of this study have shown that there is no measurable impact on human health and the environment posed by the former Simcoe gas works site. Consequently, there is no need to undertake remediation at this site.

It is, however, instructive to compare the levels of coal tar contamination measured in sediments and groundwater at the site with available regulatory standards regarding contamination and remediation at coal tar sites. Recently the Canadian Council of Resource and Environment Ministers (CCREM, now CCME) established guidelines for assessing PAH contamination at abandoned coal tar sites. Table 5.1 summarizes the "A, B, C" criteria set by CCREM for soil and groundwater contamination. CCREM recognizes carcinogenic (Group 1) and other (Group 2) PAH. At residential or agricultural land use sites, "A" levels require investigation to assess contamination and "B" levels require action to reduce exposure. "C" levels are considered significant levels of contamination. Only groundwater from BH-7 and BH-8 exceeds the "B" criteria of CCREM. Selected PAH from BH-7 and BH-8 also exceed some of "C" criteria for Group 1 and Group 2 PAH. However none of groundwater samples from the miniature piezometers exceed the "A" criteria indicating that there is no significant loading of PAH contamination to the Lynn River.

CCREM has no sediment quality criteria for PAH at coal tar sites and therefore it is not possible to compare analytical results to available regulatory criteria for sediments. However the PAH levels are low and are not considered environmentally significant.

Table 5.1 "ABC" Values for PAH in Soil and Groundwater at Coal Tar Waste Sites

| | Conc. in soil (ug/g dry weight) | | | Conc. in Groundwater (ug/L) | | |
|---|---|---|---|---|---|---|
| | A | B | C | A | B | C |
| **Group 1 Carcinogenic PAH** | | | | | | |
| benzo(a)anthracene | 0.1 | 1 | 10 | 0.01 | 0.1 | 1 |
| benzo(b)fluoranthene | 0.1 | 1 | 10 | 0.01 | 0.1 | 1 |
| benzo(k)fluoranthene | 0.1 | 1 | 10 | 0.01 | 0.1 | 1 |
| benzo(a)pyrene | 0.1 | 1 | 10 | 0.01 | 0.1 | 1 |
| dibenz(a,h)anthracene | 0.1 | 1 | 10 | 0.01 | 0.1 | 1 |
| indeno(1,2,3-cd)pyrene | 0.1 | 1 | 10 | 0.01 | 0.1 | 1 |
| **Group 2 Other PAH** | | | | | | |
| naphthalene | 0.1 | 5 | 50 | 0.2 | 2 | 20 |
| phenanthrene | 0.1 | 5 | 50 | 0.2 | 2 | 20 |
| pyrene | 0.1 | 10 | 100 | 0.2 | 2 | 20 |

# 6. CONCLUSIONS AND RECOMMENDATIONS

## 6.1 CONCLUSIONS

1. The local geology at the former gas works site consists of a top layer of fill approximately 1.5 - 3.0m thick overlying a thin peat layer 0.5 - 1.0m in thickness, which pinches out along the eastern half of the site. The peat and fill layers overlie glaciolacustrine deposits of sands and silts.

2. Unconfined groundwater flow occurs within the shallow glaciolacustrine sands and silts in an east north-east direction across the site. The average hydraulic gradient of 0.02m/m combined with a geometric mean for hydraulic conductivity of $6 \times 10^{-5}$ m/s produces a volumetric flux to the Lynn River on the order of several litres per minute. A small component of groundwater flow likely discharges to the sump located in the basement of the Simcoe Seniors' Centre building during periods of high groundwater levels.

3. Separate-phase coal tar was not identified either in on-site soils or in Lynn River sediments. However, residual coal tar contamination was identified by visual, and olfactory inspection and organic vapour measurements in parts of the fill, peat and sand units at the site. The extent of the contamination occupies an area approximately 40m x 15m between the rear of the gas plant building and Seniors' Centre and the Lynn River.

4. Groundwater contamination was identified in monitoring wells 7 and 8 which lie within the area outlined as containing residual coal tar contamination in soil and possibly miniature piezometer number 2. Groundwater contamination is identified by low concentrations of PAH and MAH compounds. Concentrations of PAH and MAH in miniature piezometers are so low as not to be reliable or environmentally significant.

5. Air quality sampling failed to detect the presence of MAH or volatile PAH compounds, characteristic of coal tar wastes, in the ambient air within and outside on-site buildings. As a result, no current impact on human health at the site is posed by the existence of the former gas works.

6. Impacts on the Lynn River from groundwater flowing through subsurface materials containing residual contamination from wastes generated from the former gas works are negligible. Groundwater discharging to the River contains trace and low levels of MAH and PAH compounds as measured in miniature piezometers installed in the River bed. These levels do not exceed the "A" criteria set by CCREM for groundwater contamination. The discharge rate of groundwater to the River from the site represents 0.004% of the total River flow rate and therefore MAH and PAH levels in groundwater discharging to the River are diluted to environmentally insignificant levels.

7. There does not appear to have been any measurable accumulation of MAH and PAH compounds in Lynn River sediments attributable to activities at the former gas plant site since concentrations of these compounds show no significant increase from sediment cores taken opposite the site with the background sample taken upstream. CCREM has no sediment quality criteria for PAH at coal tar sites, however the PAH levels in Lynn River sediments are low and are not considered to be environmentally significant.

## 6.2 RECOMMENDATIONS

1. The results of this study indicate that the former Simcoe gas works site poses no measurable impact on human health and the environment. Therefore, remediation at this site is not recommended.

2. In any future redevelopment of the site, residual coal gas plant wastes may become exposed during excavation or soil boring. Appropriate measures should be taken to protect worker and public safety by limiting exposure to coal gas plant waste. Disposal of coal gas plant wastes should be conducted in accordance with appropriate regulatory requirements.

3. Appropriate measures should be taken to protect worker safety in the event that coal gas plant wastes are exposed during maintenance of Pond Street or the utilities beneath Pond Street, in the general area of the former gas plant.

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# APPENDIX A
## Air Quality Analyses

May 23, 1990

ANALYTICAL REPORT

Samples Submitted by: Mr. Austin Sweazy,
Intera Technologies Ltd.
1525 Carling Avenue
Suite 600
Ottawa, Ontario
K1Z 8R9

Date Received: May 4, 1990

Date Completed: May 22, 1990

The adsorbent tubes received were analyzed for BTEX or naphthalene using GC/MS in the selective ion mode and the following results (in mg) were obtained.

| Sample | Benzene | Toluene | O-Xylene | M&P-Xylene | ethylbenzene | naphthalene |
|---|---|---|---|---|---|---|
| Simcoe 1 46 min at 200 ml/min | <0.02 | <0.01 | <0.01 | <0.01 | <0.01 | |
| Simcoe 2 200 min at 1 L/min | | | | | | <0.01 |
| Simcoe 3 40 min at 200 ml/min | <0.02 | <0.01 | <0.01 | <0.01 | <0.01 | |
| Simcoe 4 219 min at 1 L/min | | | | | | <0.01 |
| Simcoe 5 42 min at 200 ml/min | <0.02 | <0.01 | <0.01 | <0.01 | <0.01 | |
| Simcoe 6 200 min at 1 L/min | | | | | | <0.01 |

W Craig

W. Craig, PH. D.

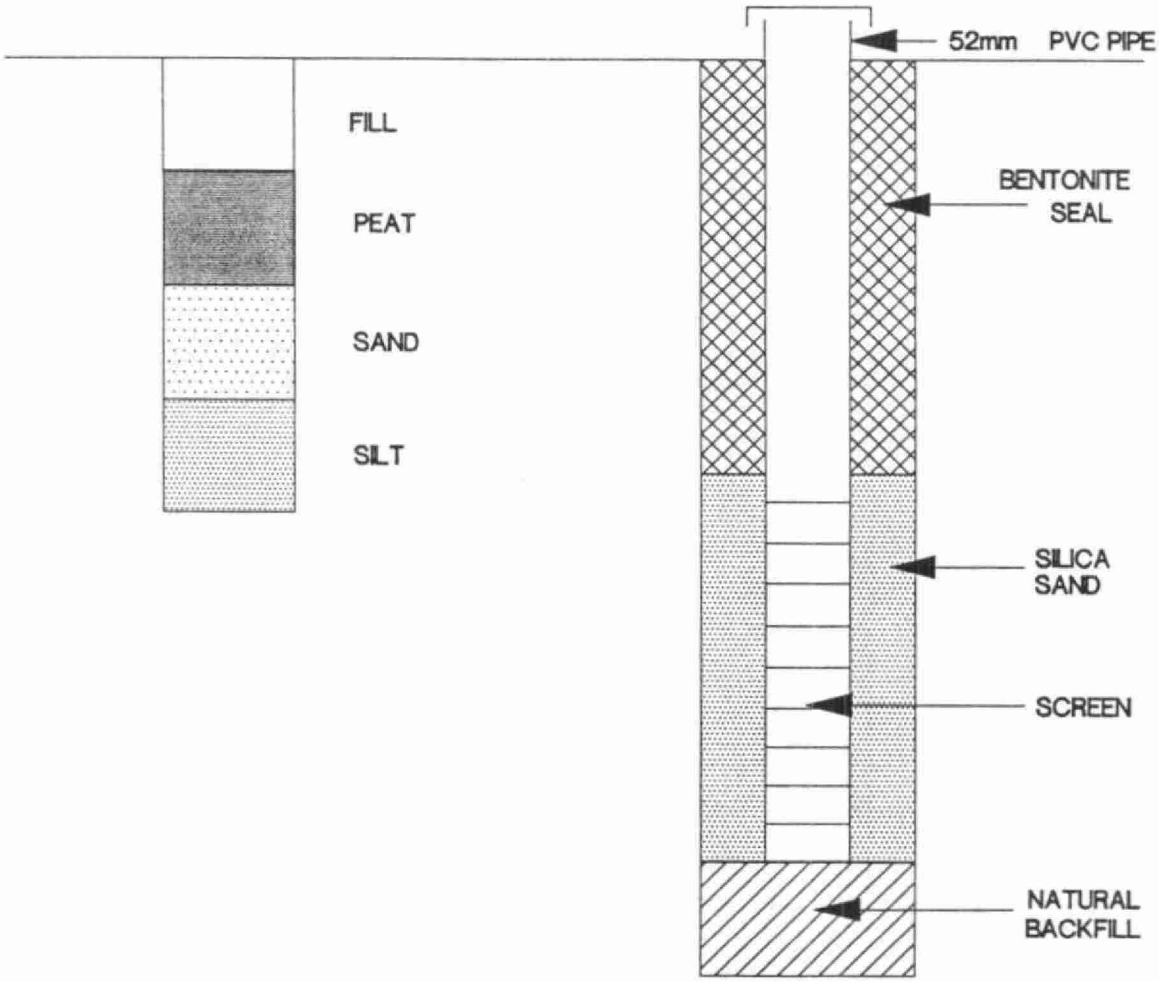
# APPENDIX B

Stratigraphic and Instrumentation Logs

Boreholes 1 to 9

# STRATIGRAPHIC AND INSTRUMENTATION LOG

## LEGEND



# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 1 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 2, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 208.58 m AMSL | DRILL SUPERVISOR: M.R.F. |

| DEPTH m BG | SAMPLE | OVM (PPM) | STRATIGRAPHIC DESCRIPTION | ELEVATION (m AMSL) | INSTALLATION |
|---|---|---|---|---|---|
| 0 | | <1 | FILL<br>- grass & topsoil (0–15cm)<br>- sandy fill<br>- dark brown<br>- dry<br>- coal and brick fragments<br>- minor gravel<br>- no odour or visual contamination | 208.58 | 0 |
| 1 | | <1 | | | 1 |
| 2 | | <1 | | | 2 |
| | | <1 | | | |
| 3 | | <1 | SAND<br>- coarse sand<br>- minor gravel<br>- wet at 3.05m<br>- medium brown<br>- no odour | 205.69 | 3 |
| 4 | | <1 | | 204.47 | 4 |
| 5 | | <1 | SILT<br>- grey/brown<br>- saturated<br>- no odour | | 5 |
| | | <1 | | 202.79 | |
| 6 | | | | | 6 |
| 7 | | | | | 7 |
| 8 | | | | | 8 |
| 9 | | | | | 9 |
| 10 | | | | | |

# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 2 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 2, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 207.98 m AMSL | DRILL SUPERVISOR: M.R.F. |

| DEPTH m BG | SAMPLE | OVM (PPM) | STRATIGRAPHIC DESCRIPTION | ELEVATION (m AMSL) | INSTALLATION |
|---|---|---|---|---|---|
| 0 | | <1 | FILL<br>- clayey sand fill<br>- brick fragments<br>- dry | 207.98 | |
| 1 | | 2 | - large wood fragments<br>- brown/black | | |
| 2 | | 3 | - coal tar odour | | |
| | | 5 | PEAT<br>- black peat<br>- silty, wet<br>- coal tar odour | 205.39 | |
| 3 | | | | | |
| 4 | | | | 204.63 | |
| 4 | | <1 | | | |
| | | <1 | SILT<br>- grey/brown<br>- saturated (soupy)<br>- no odour | | |
| 5 | | | | | |
| | | <1 | | 202.19 | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |

# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 3 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 2, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 208.11 m AMSL | DRILL SUPERVISOR: M.R.F. |

| DEPTH m BG | SAMPLE | OVM (PPM) | STRATIGRAPHIC DESCRIPTION | ELEVATION (m AMSL) | INSTALLATION |
|---|---|---|---|---|---|
| 0 | | <1 | FILL<br>- sandy fill, damp<br>- dark brown<br>- minor coal tar odour<br>- black ash/cinder<br>- brick fragments | 208.11 | 0 |
| 1 | | <1 | | | 1 |
| | | | | 206.59 | |
| 2 | | 4 | PEAT - dark brown/black organics<br>- minor coal tar odour<br>- purple sheen | 206.13 | 2 |
| | | <1 | SAND<br>- minor coal tar odour<br>- coarse sand<br>- light brown<br>- saturated | | |
| 3 | | <1 | | | 3 |
| | | | | 204.30 | |
| 4 | | <1 | SILT<br>- grey/brown<br>- saturated<br>- no odour | | 4 |
| 5 | | <1 | | | 5 |
| | | <1 | - 10cm band of silty clay at 4.88m | | |
| 6 | | <1 | - grey/brown silt | | 6 |
| | | | | 201.56 | |
| 7 | | | | | 7 |
| 8 | | | | | 8 |
| 9 | | | | | 9 |
| 10 | | | | | |

# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 4 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 1, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 208.77 m AMSL | DRILL SUPERVISOR: M.R.F. |

| DEPTH m BG | SAMPLE | OVM (PPM) | STRATIGRAPHIC DESCRIPTION | ELEVATION (m AMSL) | INSTALLATION |
|---|---|---|---|---|---|
| 0 | | <1 | FILL<br>- asphalt (0–10cm)<br>- medium brown sandy fill<br>- minor gravel<br>- brick fragments<br>- coal fragments | 208.05 | Stickup = 0.72m |
| 1 | | <1 | | | |
| 2 | | <1 | - black cinder/ash mixed with sandy fill | | |
| 3 | | <1 | PEAT<br>- humus<br>- dry, silty<br>- roots, sticks<br>- no odour | 205.76 | |
| 4 | | <1 | | | |
| 5 | | <1 | SAND<br>- medium brown<br>- saturated<br>- well sorted<br>- coarse grained<br>- no odour | 204.70 | |
| 6 | | | | 203.02 | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |

# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 5 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 1, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 208.43 m AMSL | DRILL SUPERVISOR: M.R.F. |

| DEPTH m BG | SAMPLE | OVM (PPM) | STRATIGRAPHIC DESCRIPTION | ELEVATION (m AMSL) | INSTALLATION |
|---|---|---|---|---|---|
| 0 | | <1 | FILL<br>- sandy fill<br>- light brown<br>- medium grained<br>- brick fragments<br>- coal fragments<br>- minor ash | 208.43 | 0 |
| 1 | | 2 | | | 1 |
| 2 | | 8 | - wood & brick fragments<br>- silty, moist fill | | 2 |
| | | 4 | PEAT - medium brown<br>- silty sand<br>- root fragments | 205.84 | |
| 3 | | 2 | | 205.38 | 3 |
| 4 | | <1 | SAND<br>- medium brown<br>- coarse grained<br>- saturated<br>- rounded pebbles<br>- no contamination | | 4 |
| 5 | | <1 | | 203.10 | 5 |
| 6 | | | | | 6 |
| 7 | | | | | 7 |
| 8 | | | | | 8 |
| 9 | | | | | 9 |
| 10 | | | | | |

# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 6 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 1, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 208.03 m AMSL | DRILL SUPERVISOR: M.R.F. |

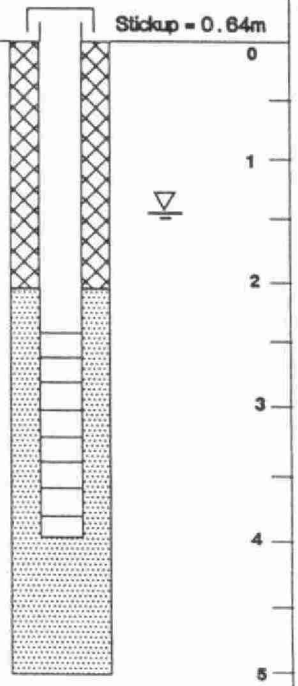
| DEPTH m BG | SAMPLE | OVM (PPM) | STRATIGRAPHIC DESCRIPTION | ELEVATION (m AMSL) | INSTALLATION |
|---|---|---|---|---|---|
| 0 | | <1 | FILL<br>- sandy fill<br>- light brown<br>- minor gravel<br>- wood fragments | 208.03 | |
| 1 | | <1 | | | |
| 2 | | <1 | - light grey/black clayey silt<br>- fine black ash<br>- no odour | 205.74 | |
| 3 | | <1 | PEAT - black/brown silty sand and organics<br>- saturated, bog odour | 205.13 | |
| 4 | | <1 | SAND<br>- light brown<br>- med. to coarse grained<br>- occasional rounded pebbles up to 4cm.<br>- no contamination | | |
| 5 | | <1 | | 202.70 | |
| 6 | | | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |

# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 7 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 1, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 208.30 m AMSL | DRILL SUPERVISOR: M.R.F. |

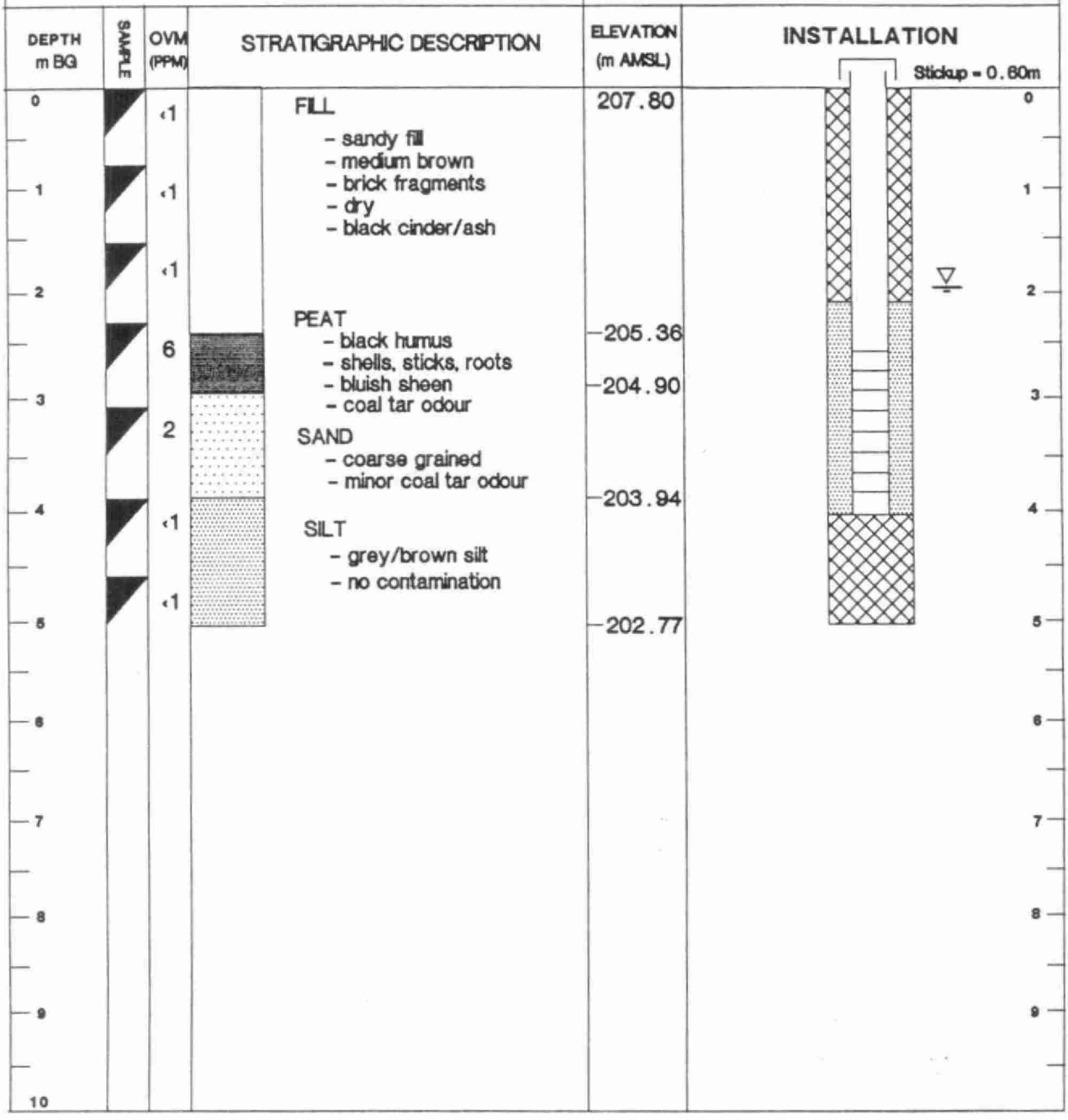
| DEPTH m BG | SAMPLE | OVM (PPM) | STRATIGRAPHIC DESCRIPTION | ELEVATION (m AMSL) |
|---|---|---|---|---|
| 0 | | <1 | FILL<br>- sandy fill<br>- medium brown<br>- minor gravel<br>- brick fragments<br>- dry | 207.66 |
| 1 | | <1 | | |
| 2 | | <1 | - brick fragments<br>- black ash/cinder<br>- minor coal tar odour | |
| | | 2 | | 205.07 |
| 3 | | <1 | SAND<br>- medium brown<br>- saturated<br>- well sorted<br>- medium to coarse grained<br>- no odour<br>- well rounded pebbles up to 4cm diameter | |
| 4 | | <1 | | |
| 5 | | <1 | | 202.63 |
| 6 | | | | |
| 7 | | | | |
| 8 | | | | |
| 9 | | | | |
| 10 | | | | |

INSTALLATION



# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 8 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 2, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 208.40 m AMSL | DRILL SUPERVISOR: M.R.F. |



# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 9 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 1, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 207.97 m AMSL | DRILL SUPERVISOR: M.R.F. |

| DEPTH m BG | SAMPLE | OVM (PPM) | STRATIGRAPHIC DESCRIPTION | ELEVATION (m AMSL) | INSTALLATION |
|---|---|---|---|---|---|
| 0 | | <1 | FILL<br>- ashphalt, sand & gravel to 0.45m<br>- medium brown sandy fill<br>- minor gravel<br>- brick fragments | 207.97 | |
| 1 | | <1 | | | |
| 2 | | 2 | - black cinder/ash<br>- clayey, sandy fill<br>- roots | | |
| 3 | | 8 | PEAT - medium brown silty peat mix<br>- coal tar odour<br>- purple sheen visible | 205.68<br>205.23 | |
| 4 | | 2 | SAND<br>- coal tar odour<br>- purple sheen visible<br>- coarse grained sand<br>- medium brown<br>- minor gravel | | |
| 5 | | <1 | - no odour in last two samples | 202.94 | |
| 6 | | <1 | | | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |

# STRATIGRAPHIC AND INSTRUMENTATION LOG

| | |
|---|---|
| PROJECT NAME AND No.: SIMCOE : T90-034 | BOREHOLE No.: 10 |
| CLIENT: ONT. MINISTRY OF ENVIRONMENT | DATE COMPLETED: MAY 2, 1990 |
| LOCATION: SIMCOE, ONTARIO | DRILLING METHOD: HOLLOW STEM AUGER |
| REFERENCE ELEVATION: 207.69 m AMSL | DRILL SUPERVISOR: M.R.F. |

| DEPTH m BG | SAMPLE | OVM (PPM) | STRATIGRAPHIC DESCRIPTION | ELEVATION (m AMSL) | INSTALLATION |
|---|---|---|---|---|---|
| 0 | | <1 | FILL<br>- grass & topsoil (0–15cm)<br>- sandy fill<br>- medium brown<br>- dry<br>- large brick fragments<br>- no odour or visual contamination | 207.69 | |
| 1 | | <1 | | | |
| 2 | | <1 | | | |
| | | <1 | PEAT<br>- mix of peat & coarse sand<br>- dark brown/black<br>- minor purple sheen<br>- no odour<br>- wet at 2.40m | 205.39 | |
| 3 | | <1 | | 204.49 | |
| 4 | | <1 | SILT<br>- grey/brown<br>- saturated<br>- no odour | | |
| 5 | | <1 | | | |
| 6 | | <1 | | 201.90 | |
| 7 | | | | | |
| 8 | | | | | |
| 9 | | | | | |
| 10 | | | | | |

# APPENDIX C
## Soil Leachate Analyses

CLIENT: INTERA, KENTING
W.O. # 90-5263L
MATRIX:REG. 309 LEACHATE

DATE: 28-May-90

RESULTS OF ANALYSIS FOR BENZO(A)PYRENE BY SIM GC/MS

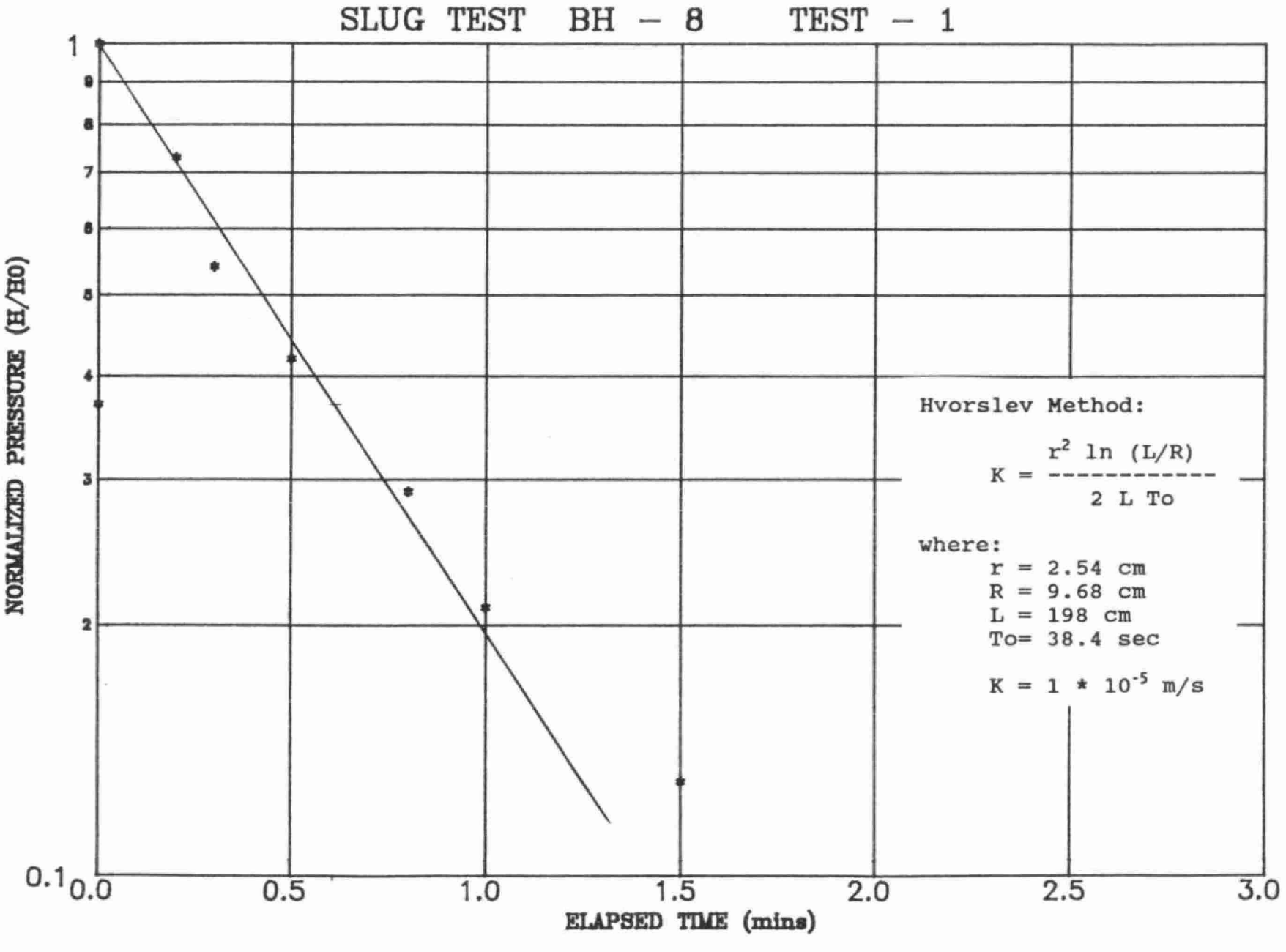
| SAMPLE | M.D.L. PPT | AMOUNT PPT | SURROGATE % RECOVERY (PERYLENE-D12) |
|---|---|---|---|
| REAGENT BLANK | 100 | <100 | 55% |
| BH8-SS3/4 | 100 | 125 | 70% |
| BH8-SS3/4 (REPEAT) | 100 | 101 | 69% |

QUALITY CONTROL SPIKE RECOVERIES FOR BENZO(A)PYRENE

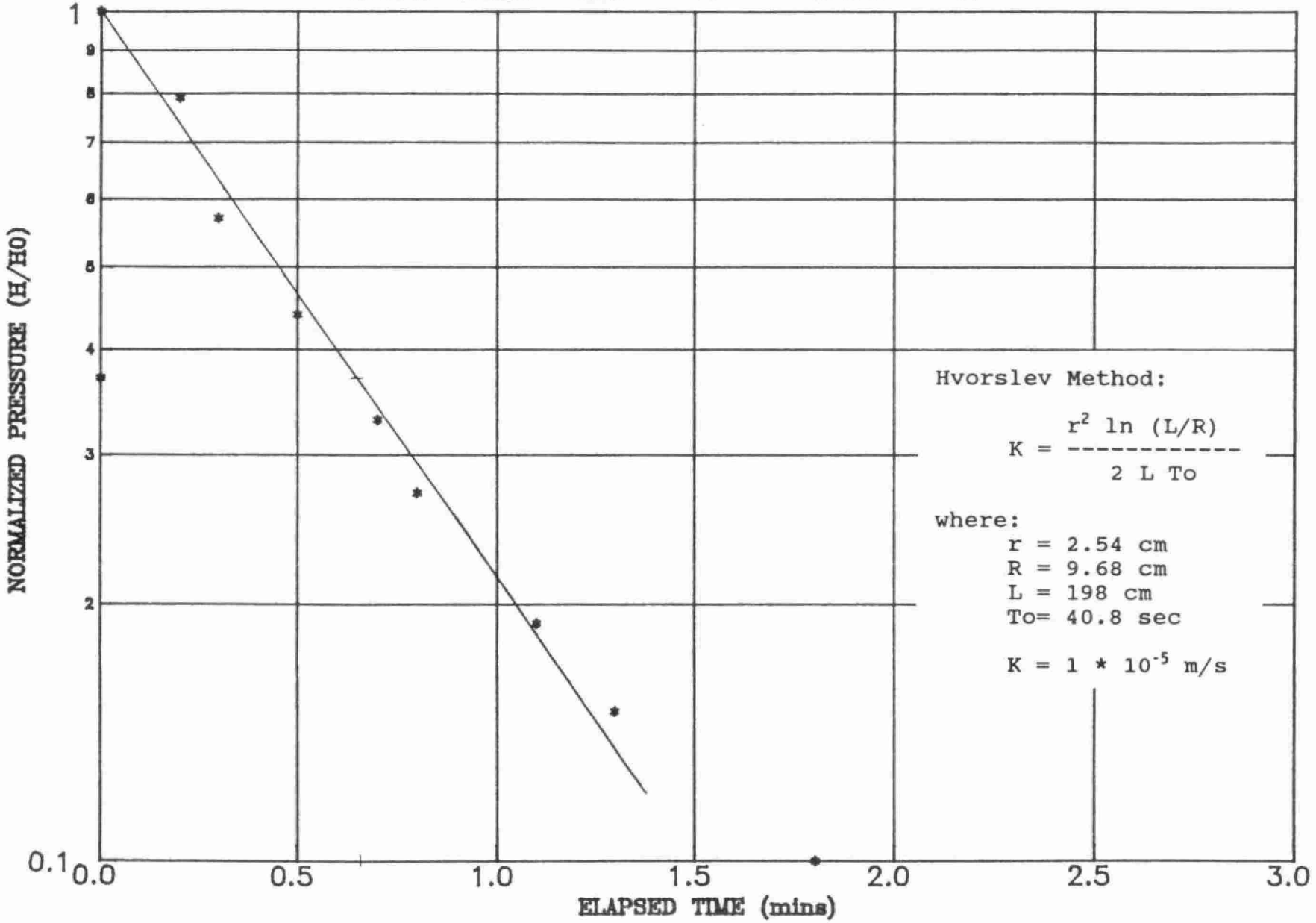
| SAMPLE | AMOUNT SPIKED PPT | PERCENT RECOVERY B(a)P | SURROGATE % RECOVERY (PERYLENE-D12) |
|---|---|---|---|
| REAGENT BLANK (SPIKED) | 500 | 115% | 71% |

# APPENDIX D

## Slug Test Results - Monitoring Well 8


SLUG TEST BH - 8 TEST - 1
NORMALIZED PRESSURE (H/HO)
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
0.5
1.0
1.5
2.0
2.5
3.0
ELAPSED TIME (mins)
Hvorslev Method:
K = r² ln (L/R) / 2 L To
where:
r = 2.54 cm
R = 9.68 cm
L = 198 cm
To= 38.4 sec
K = 1 * 10⁻⁵ m/s

# SLUG TEST BH – 8 TEST – 2



# APPENDIX E
## Water Quality Analyses

Concentration of Monocyclic Aromtic Hydrocarbons (MAH) in Water
(µg/L)

| Compound | MDL | BH-4 | BH-7 | BH-8 | MP-2 | MP-3 | MP-4 | Trip Blank | Lab Blank |
|---|---|---|---|---|---|---|---|---|---|
| Benzene | 1 | - | 9.2 | - | - | - | - | - | - |
| Chlorobenzene | 1 | - | - | - | - | - | - | - | - |
| 1,2-Dichlorobenzene | 1 | - | - | - | - | - | - | - | - |
| 1,3-Dichlorobenzene | 1 | - | - | - | - | - | - | - | - |
| 1,4-Dichlorobenzene | 1 | - | - | - | - | - | - | - | - |
| Ethylbenzene | 1 | - | 1.1 | 1.2 | - | - | - | - | - |
| A-Methylstyrene | 1 | - | - | - | - | - | - | - | - |
| Methylstyrene Isomers | 1 | - | - | - | - | - | - | - | - |
| Mesitylene | 1 | - | - | - | - | - | - | - | - |
| Toluene | 2 | - | - | - | 13 | 4.2 | 8.1 | - | - |
| M+P-Xylene | 2 | - | - | - | - | - | - | - | - |
| o-Xylene | 1 | - | - | - | - | - | - | - | - |
| Styrene | 2 | - | - | - | - | - | - | - | - |
| Other Aromatic Compounds | 1 | - | 1.4 | 4.9 | - | - | - | - | - |

- Not detected at MDL

MDL = Method Detection Limits

Other Aromatic Compounds = Total concentration of tri- and tetraethylbenzenes using the response factor of mesitylene.

## CONCENTRATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN WATER
ug/L

| COMPOUND | BH-4 | BH-7 | BH-8 | MP-1 | MP-2 | MP-3 | MP-4 | TRIP BLANK | BLANK | MDL |
|---|---|---|---|---|---|---|---|---|---|---|
| NAPHTHALENE | 0.09 | 0.08 | 0.12 | 0.07 | 0.09 | 0.05 | 0.05 | 0.06 | TR | 0.05 |
| ACENAPHTHALENE | - | 1.4 | 3.0 | - | - | - | 0.07 | - | - | 0.05 |
| ACENAPHTHENE | - | 2.5 | 82 | - | - | - | 0.05 | - | - | 0.05 |
| FLUORENE | - | 0.44 | 36 | - | - | - | - | - | - | 0.05 |
| PHENANTHRENE | - | 3.0 | 99 | - | - | - | - | - | - | 0.05 |
| ANTHRACENE | - | 0.56 | 15 | - | - | - | - | - | - | 0.05 |
| FLUORANTHENE | TR | 0.76 | 7.9 | - | 0.22 | - | - | - | - | 0.05 |
| PYRENE | 0.06 | 1.0 | 8.4 | - | 0.23 | TR | - | - | - | 0.05 |
| BENZ(A)ANTHRACENE | - | 0.11 | 0.21 | - | - | - | - | - | - | 0.05 |
| CHRYSENE | - | 0.11 | 0.15 | - | - | - | - | - | - | 0.05 |
| BENZO(B+K)FLUORANTHENE | - | 0.10 | 0.05 | - | - | - | - | - | - | 0.05 |
| BENZO(A)PYRENE | - | 0.09 | TR | - | - | - | - | - | - | 0.05 |
| INDENO(1,2,3-CD)PYRENE | - | TR | - | - | - | - | - | - | - | 0.1 |
| DIBENZ(AH)ANTHRACENE | - | - | - | - | - | - | - | - | - | 0.1 |
| BENZO(GHI)PERYLENE | - | TR | - | - | - | - | - | - | - | 0.1 |

MDL = METHOD DETECTION LIMIT
TR = TRACE

## RECOVERY OF SURROGATE STANDARDS
(%)

| COMPOUND | BH-4 | BH-7 | BH-8 | MP-1 | MP-2 | MP-3 | MP-4 | TRIP BLANK | BLANK |
|---|---|---|---|---|---|---|---|---|---|
| D8-NAPHTHALENE | 68.3 | 39.7 | 45.3 | 66.2 | 60.9 | 46 | 41.9 | 59.3 | 41.2 |
| D10-ANTHRACENE | 92.5 | 52.2 | 109 | 78.2 | 80 | 66.5 | 50.2 | 83.1 | 62.5 |
| D10-FLUORANTHENE | 98 | 52.1 | 89.6 | 90.6 | 90 | 84.1 | 56.5 | 89.4 | 66.3 |
| D12-PERYLENE | 47.4 | 21 | 36.8 | 39.8 | 43.2 | 39.8 | 27.9 | 51.4 | 38.4 |

# APPENDIX F

## Sediment Quality Analyses - Lynn River

CONCENTRATION OF POLYCYCLIC AROMATIC HYDROCARBONS IN SOIL
ug/g

| COMPOUND | SED-4 | SED-5 | BLANK | MDL | SED-1 | MDL |
|---|---|---|---|---|---|---|
| NAPHTHALENE | 0.13 | 0.07 | 0.03 | 0.01 | - | 0.1 |
| ACENAPHTHALENE | 0.03 | - | - | 0.01 | - | 0.1 |
| ACENAPHTHENE | 0.07 | 0.09 | - | 0.01 | - | 0.1 |
| FLUORENE | 0.14 | 0.10 | - | 0.01 | - | 0.1 |
| PHENANTHRENE | 1.1 | 1.6 | - | 0.01 | 0.47 | 0.1 |
| ANTHRACENE | 0.29 | 0.39 | - | 0.01 | 0.25 | 0.1 |
| FLUORANTHENE | 1.1 | 2.7 | - | 0.01 | 1.2 | 0.1 |
| PYRENE | 0.92 | 2.3 | - | 0.01 | 1.3 | 0.1 |
| BENZ(A)ANTHRACENE | 0.52 | 0.71 | - | 0.01 | 0.51 | 0.1 |
| CHRYSENE | 0.43 | 1.4 | - | 0.01 | 0.74 | 0.1 |
| BENZO(B+K)FLUORANTHENE | 0.61 | 1.4 | - | 0.01 | 0.89 | 0.1 |
| BENZO(A)PYRENE | 0.41 | 0.82 | - | 0.01 | 0.57 | 0.1 |
| INDENO(1,2,3-CD)PYRENE | 0.22 | 0.70 | - | 0.02 | 0.31 | 0.2 |
| DIBENZ(AH)ANTHRACENE | 0.12 | 0.25 | - | 0.02 | TR | 0.2 |
| BENZO(GHI)PERYLENE | 0.18 | 0.29 | - | 0.02 | 0.30 | 0.2 |

MDL = METHOD DETECTION LIMIT

RECOVERY OF SURROGATE STANDARDS
(%)

| COMPOUND | SED-4 | BLANK | SED-1 |
|---|---|---|---|
| D8-NAPHTHALENE | 62.2 | 48.9 | 37.9 |
| D10-ANTHRACENE | 91.7 | 55.9 | 79.2 |
| D10-FLUORANTHENE | 89.8 | 82 | 103 |
| D12-PERYLENE | 110 | 80.5 | 140 |